

T H E
General Gauger :

O R, T H E
Principles *and* Practice
O F G A U G I N G

B E E R, W I N E, *and* M A L T.

C O N T A I N I N G,

- I. Decimal Arithmetick, the Extraction of the Square and Cube-Roots, and the Use of them in the Way of *G A U G I N G*.
- II. The Necessary Problems in Geometry relating to *Gauging and Measuring*.
- III. The Use of the *S L I D I N G - R U L E* in Measuring Timber, and other Surfaces and Solids.
- IV. The Theory and Practice of *G A U G I N G* in all the Varieties, perform'd by *Pen*, and *Sliding-Rule*. Each Proposition being Wrought in *Beer, Wine, and Malt*.
- V. The Construction of the Table of *Segments*, and all the Varieties of Ullaging of Casks.
- VI. A Table of *Area's* in Malt Bushels, &c.

To which is added,

An APPENDIX for measuring Boards, Timber, Stone, &c.
With Rules and Examples for measuring most sorts of superficial and solid Figures: Also surveying of Land.

The whole laid down more methodically than any Performance of this Nature yet extant.

By Mr. *J O H N D O U G H A R T Y*,
Teacher of the Mathematicks at *Worcester*.

The Fifth Edition, Corrected by the Author.

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James A. Hall

his Book 1769

James H. Brody

1774

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ADVERTISEMENT.

WRiting and Arithmetick, Vulgar, Decimal, Instrumental, and by the Logarithms, Algebraical and Geometrical: Also Trigonometry, both Plain and Spherical, with their Applications in Measuring, Boards, Glass, Land, Timber, Stone, &c. Book-keeping, Gauging, Navigation, *i. e.* Plain, Mercator and Great-Circle Sailing, Dialling, and Astronomy, are Taught by the AUTHOR, at his House in *Worcester*: Where Youth for more Expedition may be boarded.

THE

The Holdsworth

To the Honourable,

Foot Onslow,
William Strong, } Esq;
George Townsend, }
Philip Ryley,
Sir Marmaduke Wyvil, Knight.
Edward Noel, } Esq;
—Mountague, }

Chief Commissioners and Governours for
the Management and Receipt of Her
Majesties Revenue of Excise, within
the Kingdom of *England*, &c.

Honoured Sirs,

HAVING some time to spare
from my publick Business, I
thought I could not spend it better
than in composing Something for
the Edification of young Officers.

A 2

And

DEDICATION.

And having now finished what I did design, and being perswaded into a Resolution to print it, I thought my self obliged by the Nature of the Subject, humbly to dedicate the same to your Honours, as being the only Persons that seem to encourage Industry of this Nature ; as may be seen by the many prudent and ingenious Instructions which your Inferiour Officers daily receive, to the great Advancement of Her Majesties Revenue, your own Everlasting Honour, and the general Satisfaction of all Subjects, but particularly,

Your most humble Servant,

John Dougharty.

T H E

P R E F A C E.

THOUGH the Subject I here treat of, has been accurately pursued by Men of Learning and Merit, yet I can't forbear saying, that Gaugers (for whose Benefit I chiefly write) have long been at a Loss, for want of a methodical Introduction, suited to the Capacities of Beginners, and adapted to the Practice in which they are employ'd.

Most Books upon this Subject throw a Man directly into the Mensuration of Solids, without leading him gradually thro' the previous Parts of Knowledge, upon which the Doctrine and Calculation of the Mensuration of Solids is grounded: And by this means it comes to pass that the general Practice of Gauging is done by Rote, and all that they know of the Matter is precarious.

THE PREFACE.

rious. Not to mention that their Task is much more difficult, when only the Memory is loaded with stiff Rule and Precept, than when the Judgment is called in, and the Consequences of Practice are shewn to flow naturally, easily, and coherently, from the plain and distinct Grounds laid down before.

'Twas upon this Consideration that I chalk'd down the Method here observed. I begin with the first and simplest Principles, and so rise gradually to what is built upon 'em. 'Tis acknowledged on all Hands, that the Calculation of Gauging is most expeditiously and conveniently done by that Sort of Arithmetick which is call'd Decimal; and which for Facility and Dispatch has much the Advantage of the vulgar Fractional Way. For this Reason I begin with a regular and plain Account of all the Operations of Decimal Arithmetick; taking care still to apply the Examples to the Subject of a Gauger's Employment, that he may see the Use and Necessity of this Part of Knowledge in his Way.

Next

THE PREFACE.

Next is the Extraction of the Square and Cube Roots, the Use of both which is illustrated in such Geometrical Problems, as lead to, and are the Foundation of, the Mensuration of Solids, of which Gauging is a Part.

This done, I conduct my Reader to the Doctrine of Proportions contain'd in the Rule of Three, and shew the useful and ready Application of it in such Problems as give light to the Practice of Gauging.

Having thus prepared my young Gauger, I should have led him directly to the Gauging Part; but that I thought my self obliged to give him to understand the Use and Practice of a very useful Instrument, called, the Sliding-Rule, which shortens the Calculation. This I exemplify and apply to all the Cases above-mentioned, that the young Scholar may now apply himself to the gauging Part, being equally qualified for working the Rules both by Pen and Instrument.

As for the Practice of Gauging it self, to which all the above-mentioned Parts are but Preliminaries, I apply it to all the Varieties

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ties requisite ; and discuss each Proposition both by Pen and Sliding-Rule, in its proper Place. For the greater Conveniency of the Reader, and the Illustration of the Matter, I clear every Proposition, by Rule, by Examples, by Operation, and by proper Schemes. The Examples I make use of are in Beer, Wine, and Malt ; and the Operation is perform'd both by Pen and Sliding-Rule.

For the farther Instruction and Satisfaction of the young Gauger, I have added at the latter End, a Table of Circles Areas in Malt Bushels ; together with a Table to gauge right-lin'd Figures.

Such are the Method, Design, and Contents of the Treatise I here publish : And tho' I cannot be so vain as to plead much upon its Merit, yet I hope the Plainness and Easiness of the Method, and the natural Application of its Rules, will atone, in some Measure, for its Imperfections.

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T H E

General GAUGER, &c.

Of Decimal Arithmetick.

WHO was the Inventor of this Kind of Arithmetick is uncertain; however, the first that professedly treated of this Subject, and gave it the Name of *Disms* or *Decimals*, was *Simon Stevinus*, as *Dr. Wallis* thought. But whoever it was, 'tis no matter, since our Thanks or Praise will do him no good; though indeed we ought to have a great Veneration for the very Name of such Persons whose Labours we are the better for.

It is certain that amongst the several Inventions of Man, there is not any thing of greater Use than this most excellent Part of Arithmetick: Without which the most useful Parts of mixt Mathematicks would become so troublesome, that it would hinder the most patient Soul from attempting any thing that is Praise-worthy.

An Officer in the Excise therefore ought not to be satisfied with less than the very Grounds and Reasons thereof, before he dare undertake to do any thing of Business. I have not insisted so much hereon as may be expected, yet what is done is very sufficient to so small a Tract as this.

Notation of DECIMALS.

A Decimal Fraction is such a Fraction whose Denominator is never expressed in Operation, but always known to be 10, 100, 1000, 10000, &c.

And such a Fraction is known from a whole Number, by having a Comma or Point set on the Left side thereof.

Thus .57 is a Decimal Fraction, whose Denominator is an 100, for the Denominator of a Decimal Fraction is an Unite with as many Cyphers set on the Right side thereof, as there were Figures or Places in the Decimal given; so the Denominator of .5 is 10, of .25 is 100, of .127 is 1000, and of .02 is 100, &c. And these, or any one of the same Nature, may be expressed and read as a Vulgar

Fraction; thus	$\frac{5}{10}$	$\frac{25}{100}$	$\frac{127}{1000}$	$\frac{02}{100}$
----------------	----------------	------------------	--------------------	------------------

Note, that as Cyphers placed on the Right Side of whole Numbers encrease them in a decuple Proportion, so does Cyphers set on the Left side of a decimal Number decrease them in the same proportion.

EXAMPLE.

If on the right side of 6 you place a Cypher, it will be 60, which is ten times more than it was before; so if you place a Cypher before .6 'tis .06, which is ten times less than before.

Also if you set Cyphers on the Right Side of Decimals, you'll encrease the Value thereof no more than you'd do if you had placed Cyphers on the Left side of Integers.

EXAMPLE.

Let .27 be a Decimal, on the right Side of which if you place 5 Cyphers, 'twill stand thus .2700000, but if we set

.27

,27 over its imagin'd Denominator 'tis $\frac{27}{100}$ and ,2700000

over its proper Denominator 'tis $\frac{2700000}{10000000}$; now if we conceive the last as a vulgar Fraction given to be reduced into its lowest Terms, 'tis done by taking as many Cyphers from the Denominator as from the Numerator, or cut so many off both, by a dash of your Pen, and 'tis $\frac{27}{100} \frac{00000}{00000}$ which shews it was not encreased by those Cyphers.

Addition of *Decimals*.

As in Addition of whole Numlers, so here only you must always remember to set Units under Units, and Primes under Primes, &c. then add them as Integers, placing a Comma in the Aggregate, under those in the Sums given,

E X A M P L E.

l.		
425,73	42,56	432,76
362,21	3,2	25,
43,56	,57	36,
5,23	,362	42,
6547	,0521	33,
Sum 843,277	Sum 46,7441	Sum 569,13
yr.		
87,642	763,57	428,27
,362	36,27	362,573
,353	36,27	621,
,423	62,75	321,
2,572	62,75	423,
,425	62,7232	23,
,00235	1024,3332	5,
91,77935		2183,843



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In all the preceding Examples you may take notice that the Points in the Summs stand just under the Points in the Numbers given; which if you make before you begin to add them, the Figures will fall in their proper Places.

Addition of Beer or Ale Measure.

Note, That 34 Gallons (by an Act of the first of *William and Mary*) is one Barrel both of Beer and Ale; therefore the Firkin is $8\frac{1}{2}$ Gallon, i. e. 8. 5.

Bar.	F.	Gal.	Bar.	F.	Gal.	Bar.	F.	Gal.
365	: 3	: 8,4	625	: 2	: 8,1	357	: 3	: 5,7
325	: 3	: 7,1	57	: 3	: 2,2	825	: 2	: 2,6
472	: 2	: 5,3	57	: 2	: 3,5	843	: 3	: 0,2
846	: 2	: 5,7	82	: 3	: 7,4	562	: 2	: 0,5
325	: 3	: 1,5	87	: 3	: 6,7	827	: 3	: 0,8
365	: 2	: 1,7	57	: 2	: 5,7	423	: 0	: 0,2
Sum 2702	: 2	: 4,2	12	: 3	: 8,0	3840	: 2	: 1,5
			982	: 2	: 7,6			

In all these Examples, you are for every 8,5 Gallons (in the Gallons and Parts Place) to carry one Firkin to the Line of F, and for every 4 in the line of F you are to take One to the Barrels. The very Examples answered are a sufficient Explanation.

Subtraction of Decimals.

The same Rule is to be observed here as in Addition, i. e. in placing your Figures; for if you set the Point among the Remainders, under the Points in the Number given to be subtracted; after Units are set under Units, and Primes under Primes, &c. you'll have the true place thereof.

E X.

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EXAMPLE.

	<i>l.</i>	<i>l.</i>	<i>l.</i>
From	25,72	92,723	62,762
Take	<u>12,972</u>	<u>4,32</u>	<u>19,2</u>
Remains	12,748	88,403	43,562

	<i>Gals.</i>	<i>Gals.</i>	<i>Gals.</i>
From	72,027	72,63	4,
Take	<u>12,</u>	<u>1,927</u>	<u>3,2657</u>
Remains	60,027	70,703	0,7343

Subtraction of Beer Measure.

	<i>Bar. F. Gal.</i>	<i>Bar. F. Gal.</i>
From	365 : 2 : 7,5	272 : 3 : 5,5
Take	<u>192 : 3 : 3,6</u>	<u>192 : 3 : 7,8</u>
Remains	172 : 3 : 3,9	079 : 3 : 6,2

	<i>Bar. F. Gal.</i>	<i>Bar. F. Gal.</i>
From	962 : 3 : 2,5	836 : 2 : 2,7
Take	<u>196 : 3 : 7,2</u>	<u>192 : 1 : 8,2</u>
Remains	765 : 3 : 3,8	644 : 0 : 3,0

In the Two last Examples, seeing you can't take 7,2 Gall. out of 25 Gall. nor 8,2 out of 2,7; you must borrow One Firkin, viz. 8,5 Gall. which add to 2,5 or 2,7, and take 7,2 and 8,2 out of the Sum, and the Remainder in one will be 3,8 and in the other 3,0; then pay what you borrow'd to its proper Place, as you see is done in the foregoing Operations; which Method ought to be observed in all others of the same nature.

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Multiplication of *Decimals*.

GENERAL RULE.

Multiply as in whole Numbers, and from the Product (towards the Right Hand) cut off so many Figures as there are decimal Places in both the Multiplier and Multipland; but if the Product consisteth not of so many Figures (as according to this Rule) you ought to cut off, you must supply the defect by prefixing one or more Cyphers.

EXAMPLES.

$\begin{array}{r} 3,255 \\ 3,26 \\ \hline 19530 \\ 6510 \\ 9765 \\ \hline \end{array}$	$\begin{array}{r} ,3894 \\ ,678 \\ \hline 31152 \\ 27258 \\ 23364 \\ \hline \end{array}$	$\begin{array}{r} 3,728 \\ 5,43 \\ \hline 11184 \\ 14912 \\ 18640 \\ \hline \end{array}$
Products 10611,30	,2640132	20,24304
$\begin{array}{r} 2,5623 \\ ,0235 \\ \hline 128115 \\ 76869 \\ 51246 \\ \hline \end{array}$	$\begin{array}{r} ,38602 \\ ,123 \\ \hline 115806 \\ 77204 \\ 38602 \\ \hline \end{array}$	$\begin{array}{r} ,1235 \\ ,036 \\ \hline 7410 \\ 5705 \\ \hline \end{array}$
,06021405	,04748046	,0044460

In the three last Examples the Product did not consist of so many Figures as by the general Rule ought to be cut off; therefore the Cyphers were prefix'd to make them so many.

Division.

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Division of Decimals.

GENERAL RULE.

You must always cause the Decimal Places in the Dividend to exceed those in the Divisor by about four or five, by setting Cyphers on the Right Side thereof, &c. then after the Work is done, prick off with your Pen from the Right Hand of the Quotient so many Figures as is the Excess; but if the Quotient consisteth not of so many Figures as by this Rule you ought to cut off, you must prefix so many Cyphers as will make 'em up so many.

EXAMPLES of all the Nine Cases.

CASE I.

To divide a whole Number by a whole Number, set any Number of Cyphers behind the Dividend, &c.

$$\begin{array}{r} 236 \,) 2562.0000 \text{ (10,8559} \\ 236 \end{array}$$

$$\begin{array}{r} 2020 \\ 1888 \end{array}$$

$$\begin{array}{r} 1320 \\ 1180 \end{array}$$

$$\begin{array}{r} 1400 \\ 1180 \end{array}$$

$$\begin{array}{r} 2200 \\ 2124 \end{array}$$

$$\begin{array}{r} 76 \end{array}$$

CASE

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CASE II.

To divide a mix'd by a whole Number.

$$\begin{array}{r} 96.) \ 58,3200 \quad (,6075 \\ 576 \end{array}$$

$$\begin{array}{r} 720 \\ 672 \end{array}$$

$$\begin{array}{r} 480 \\ 480 \end{array}$$

0

Note, The Decimal was but ,32, and the Two Cyphers were added to make the Decimals in the Quotient come nearer the Truth than before it would have done.

CASE III.

To divide a whole Number by a mix'd.

$$3.27) \ 325,0000000 \quad (99,38837$$

$$2943$$

$$3070$$

$$2943$$

$$1270$$

$$981$$

$$2890$$

$$2616$$

$$2740$$

$$2616$$

$$1240$$

$$981$$

$$2590$$

$$2289$$

$$301$$

CASE

CASE IV.

To divide a whole Number by a Decimal Fraction.

$$\begin{array}{r}
 .572 \overline{) 3648, 000000} \quad (6377,622 \\
 \underline{3432} \\
 2160 \\
 \underline{1716} \\
 4440 \\
 \underline{4004} \\
 4360 \\
 \underline{4004} \\
 3560 \\
 \underline{3432} \\
 1280 \\
 \underline{1144} \\
 1360 \\
 \underline{1144} \\
 216
 \end{array}$$

CASE V.

To divide a mix'd Number by a mix'd Number.

$$\begin{array}{r}
 1,25 \overline{) 325,7000} \quad 260,56 \\
 \underline{250} \\
 757 \\
 \underline{750} \\
 700 \\
 \underline{625} \\
 750 \\
 \underline{750} \\
 0
 \end{array}$$

CASE

The General Gauger.

C A S E VI.

To divide a mix'd Number by a Decimal Fraction.

$$\begin{array}{r}
 .543 \overline{) 36.2500000} \quad (66.7587 \\
 \underline{3258} \\
 3670 \\
 \underline{3258} \\
 4120 \\
 \underline{3801} \\
 3190 \\
 \underline{2715} \\
 4750 \\
 \underline{4344} \\
 4060 \\
 \underline{3801} \\
 259
 \end{array}$$

C A S E VII.

To divide a Decimal Fraction by a whole Number.

$$\begin{array}{r}
 27 \overline{) .32000000} \quad (.01185185 \\
 \underline{27} \\
 50 \\
 \underline{27} \\
 230 \\
 \underline{216} \\
 140 \\
 \underline{135} \\
 50 \\
 \underline{27} \\
 230 \\
 \underline{216} \\
 140 \\
 \underline{135} \\
 5
 \end{array}$$

C A S E

CASE VIII.

To divide a Decimal Fraction by a mix'd Number.

$$\begin{array}{r}
 13.26 \overline{) 36205627} \quad (.027304 \\
 \underline{2652} \\
 9685 \\
 \underline{9282} \\
 4036 \\
 \underline{3978} \\
 005827 \\
 \underline{5304} \\
 523
 \end{array}$$

CASE IX.

To divide a Decimal Fraction by a Decimal Fraction.

$$\begin{array}{r}
 .162 \overline{) .8727587} \quad (5.3873 \\
 \underline{810} \\
 .627 \\
 \underline{486} \\
 1415 \\
 \underline{1296} \\
 1198 \\
 \underline{1134} \\
 647 \\
 \underline{486} \\
 161
 \end{array}$$

Reduction of Decimals.

When the Parts of the Integer given are reduced to such a Vulgar Fraction as is proper for the same, all such Fractions are reduced to decimal Fractions by the Proportion following.

That

*The General Gauger.**That is,*

As the Denominator of that Vulgar Fraction is to its Numerator, so is 10, 100, 1000, 10000, or 100000, &c. to their particular Numerators, which Numerator is the Decimal required.

E X A M P L E I.

What decimal Part of a Barrell of Beer is Five Gallons?

Because in One Barrell are 34 Gallons, therefore the Vulgar Fraction will be $\frac{5}{34}$.

Then the Proportion to find the Decimal Fraction is as

$$34 : 5 :: 10000$$

$$\begin{array}{r} 34 \overline{) 50000} \quad (.147 \text{ facit} \\ \underline{34} \\ 160 \\ \underline{136} \\ 240 \\ \underline{238} \\ 20 \end{array}$$

E X A M P L E II.

What decimal Part of a Gallon is two Pints?

In One Gallon are Eight Pints, therefore the Vulgar Fraction will be $\frac{2}{8}$, i. e. $\frac{1}{4}$, and the proportion is as

$$4 : 1 :: 100$$

$$\begin{array}{r} 4 \overline{) 100} \quad (.25 \text{ facit.} \\ \underline{80} \\ 20 \end{array}$$

*E X A M P L E III.**s. d.*

What decimal Part of a Pound Sterling is 15 : 4?

12

34

15

Or what decimal Part of a Pound is

184 pence?

In

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13

In One Pound is 240 Pence, therefore the Vulgar Fraction will be $\frac{184}{240}$, and the Proportion as 240:

$$184 :: 100000$$

$$184$$

$$240 \cdot 184.00000 (.76666 \text{ Answer})$$

$$1680$$

$$1600$$

$$1440$$

$$1600$$

$$1440$$

$$1600$$

$$1440$$

$$1600$$

$$1440$$

$$160$$

EXAMPLE IV.

What decimal Part of a Pound Sterling is $3 : 4\frac{3}{4}$?

$$12$$

$$40$$

$$4$$

$$\text{as } 960 : 163 :: 10000 : ,1697$$

facit ,1697.

163 Farthings.

EXAMPLE V.

What decimal Part of a Foot is 3 Inches?

The Number of Inches in One Foot is 12, therefore the vulgar Fraction will be $\frac{3}{12}$. i. e. $\frac{1}{4}$, and the Proportion is as 4 : 1 :: 100 : ,25.

$$4 \cdot 1.00 (.25 \text{ facit})$$

$$2(0$$

When a decimal Fraction is given to find the Value thereof.

RULE.

Multiply the Decimal given by so many of the next inferior Denomination as will make that Integer of which the given

C

given

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given Decimal is a Part, and from the Product cut off so many Figures as there were Places in the Decimal given.

E X A M P L E I.

What is the Value of ,752 of a pound Sterling?

$$\begin{array}{r}
 20 \\
 \hline
 15,040 \text{ Shillings} \\
 12 \\
 \hline
 ,480 \text{ Pence} \\
 4 \\
 \hline
 1,920 \text{ Farthings}
 \end{array}$$

Answer *s. d. qt.*
 15 : 00 : 1,92

E X A M P L E II.

What is the Value of ,027 of a pound Sterling?

$$\begin{array}{r}
 ,027 \\
 20 \\
 \hline
 ,540 \text{ Shillings.} \\
 12 \\
 \hline
 1080 \\
 540 \\
 \hline
 6,480 \text{ Pence} \\
 4 \\
 \hline
 1,920 \text{ Farthings}
 \end{array}$$

Answer *s. d. qt.*
 00 : 6 : 1,92

E X A M P L E III.

What is the Value of ,952 of a Pound Sterling?

$$\begin{array}{r}
 20 \\
 \hline
 19,040 \text{ Shillings} \\
 12 \\
 \hline
 ,480 \text{ Pence} \\
 4 \\
 \hline
 1,920 \text{ Farthings}
 \end{array}$$

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15

A more short Way to find the Value of a Pound Sterling.

R U L E.

Double the Figure which standeth next the Point in the Decimal given; and if the next Figure towards the Right Hand the aforesaid is 5 or more, add 1 to the Product; then what Figure stands in the second Place, above or under 5, reckon so many Tens of Farthings, and what stands in the third Place from the Prick is so many Farthings; which, as often as they are above 13, make less by 1, or above 39, make less by 2.

E X A M P L E. IV.

What is the Value of ,482 of a Pound Sterling?

$$\begin{array}{r} 9 : 7\frac{3}{4} \text{ facit} \\ s. \quad d. \end{array}$$

E X A M P L E V.

What is the Value of ,875 of a Hundred Weight Averdupoize?

$$\begin{array}{r} 4 \\ \hline 3,500 \text{ Quarters.} \\ 28 \\ \hline 14,000 \text{ Pounds.} \end{array}$$

E X A M P L E VI.

What is the Value of ,623 of a Barrel of Beer?

$$\begin{array}{r} 1 \\ \hline 2,492 \text{ Firkins.} \\ 8,5 \\ \hline 2460 \\ 3936 \\ \hline 4,1820 \text{ Gallons.} \\ 8 \\ \hline 1,4560 \text{ Pints.} \end{array}$$

F. G. P

Facit 2 : 4 : 1,456

C 2

To

To extract the Square Root.

TO extract the Square Root of any given Number, is to find a Number, which multiplied into it self shall produce the Number given; and this is of great Use in Gauging, for finding mean Proportionals, &c.

When a Number is given, whose Square Root is required, you must first make a Point over every other Figure, beginning at Unity, and so many Points as you have, so many Figures you must expect in the Root required.

EXAMPLE.

Let the Square given be 472738, which being pointed (as is above directed) is 472738, by which I conclude that the Root will have Three Places, because the Points are Three which stand over the given Square.

Your next Business is to find the Root of the greatest Square to the first Point; which in this Case you'll find to be 6, for the Square thereof is 36, that being the next lesser Square to the first Point, viz. 47; this 36 I take from 47, and place the Root, viz. 6, in the Quotient, and the Work will stand thus,

$$\begin{array}{r} 472738 \quad (6 \\ \underline{36} \\ 11 \end{array}$$

To the last Remainder I must bring down all the Figures in the next Point, and then 'tis

$$\begin{array}{r} 472738 \quad (6 \\ \underline{36} \\ 1127 \end{array}$$

And for a Divisor, I double the Quotient, and 'tis

$$\begin{array}{r} 472738 \quad (6 \\ \underline{36} \\ 12) 1127 \end{array}$$

Then

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17

Then enquire how many times you can have 12 in 112, which you can have but 8 times, set your 8 behind the Divisor, and also in the Quotient, and 'twill stand thus,

$$\begin{array}{r} 472738 \quad (68 \\ \underline{36} \end{array}$$

$$128) \quad 1127$$

Multiply 128 by 8, and subtract the Product from 1127, and the Remainder will be 103, as in the following.

$$\begin{array}{r} 472738 \quad (68 \\ \underline{36} \end{array}$$

$$\begin{array}{r} 128) \quad 1127 \\ \underline{1024} \\ 103 \end{array}$$

To the last Remainder, viz. 103, I bring down all in the next Point, viz 38, and double the Root (viz. 68) for a Divisor, and it will stand thus,

$$\begin{array}{r} 472738 \quad (68 \\ \underline{36} \end{array}$$

$$\begin{array}{r} 128) \quad 1127 \\ \underline{1024} \end{array}$$

$$136) \quad 10338$$

Then again enquire how many times 136 in 1033 (for 8 is to be reserv'd for the Square of the Figure that is to be found) which is 7 times; which you must place in the Root, and behind the double Root, and the Work is as below;

$$\begin{array}{r} 472738 \quad (687 \text{ Root} \\ \underline{36} \end{array}$$

$$\begin{array}{r} 128) \quad 1127 \\ \underline{1024} \end{array}$$

$$\begin{array}{r} 1367) \quad 10338 \\ \underline{9569} \end{array}$$

769 remains.

C 3

But

Then

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But if more Exactness be required (as to have the Root consist of 6 or 7 Places of Decimals) you may annex 12 or 14 Cyphers to the Square given, and then extract, as by the foregoing Example you are directed, so will your Root consist of whole Numbers and Decimals as followeth. *

472738,00000000000000 (687.5594519
36

* Where Note, That if the Number of decimal Places in the Number given are not even, you ought to make 'em so, by putting one Cypher on the right Side before you begin to extract.

128) 1127
1024

1367) 10338
9569

13745) 76900
68725

137505) 817500
687525

1375109) 12997500
12375981

13751184) 62151900
55004736

137511885) 714716400
687559425

1375118901) 2715697500
1375118901

13751189029) 134057859990
12376070121

1029715863 remains.

The

The Use of the Square Root.

P R O B. I.

To find a mean Proportional between any Two Numbers.

R U L E.

Multiply one of the Numbers given by the other, and the Square Root of that Product is the mean Proportional sought.

E X A M P L E.

What is the Mean between 46 and 62?

$$\begin{array}{r}
 46 \\
 \hline
 372 \\
 248 \\
 \hline
 2852, (53, 42, \&c. \\
 25 \\
 \hline
 103) \quad 352 \\
 \quad 309 \\
 \hline
 1064) \quad 4300 \\
 \quad 4256 \\
 \hline
 1068) \quad 4400
 \end{array}$$

Answer 53, 4

By

The

The General Gauger.

By the foregoing Rule you'll find the Means between

{ 32	{ to be	38, 36, &c.
{ 8		
{ 46		
{ 82	{ to be	63, 30, &c.
{ 8		
{ 49		
{ 47	{ to be	54, 85, &c.
{ 8		
{ 64		

P R O B. II.

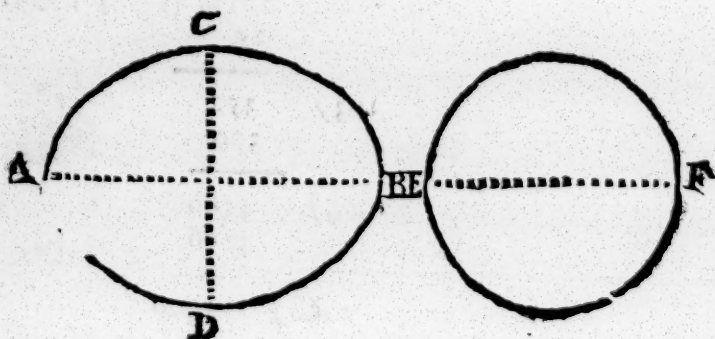
To find the Diameter of a Circle which shall be equal in Area to any Oval, whose Conjugate and transverse Diameters are given.

R U L E.

Multiply the Conjugate by the transverse Diameter, and extract the Square Root of the Product, which Root is the Diameter of that Circle, whose Area is equal to that of the Oval.

E X A M P L E.

Let AB be the transverse Diameter of an Oval, which let it be 46 Inches, and let CD be the Conjugate equal to 32 Inches, I demand the Diameter EF of that Circle, which shall be equal thereto in Area.



$$\begin{array}{r}
 46 \\
 \underline{32} \\
 92 \\
 \underline{138} \\
 1472 \\
 \underline{9} \\
 68) 572 \\
 \underline{544} \\
 763) 2800 \\
 \underline{2289} \\
 7666) 511,00
 \end{array}$$

(38,36 facit)

P R O B. III.

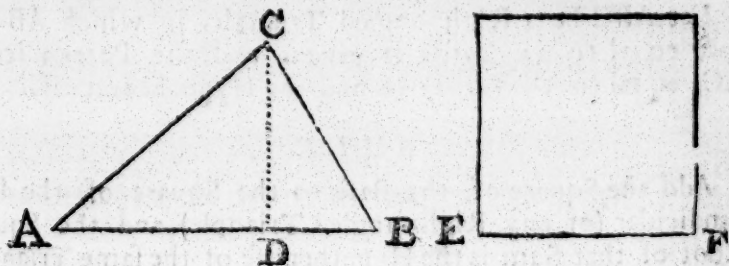
To find the Side of a Square EF, which shall be equal in Area to any given Superficies.

R U L E.

Find the Area of the given Superficies, and the Square Root thereof shall be the Side of a Square whose Area shall be equal to that of the Superficies given, whether it be a Circle, Oval, Triangle, Parallelogram, &c.

E X A M P L E.

There is a Triangle whose Base AB is 45 Inches, and Perpendicular CD 30: I demand the Side of a Square which shall be equal in Area to the said Triangle.



$$\begin{array}{r}
 45 \\
 15 \text{ half the Perpendicular CD} \\
 \hline
 225 \\
 45 \\
 \hline
 675,0000 \text{ (25,97 the Side EF of the Sq.)} \\
 4 \\
 \hline
 45) \quad 275 \\
 \quad 225 \\
 \quad \hline
 509) \quad 5000 \\
 \quad \quad 4581 \\
 \quad \quad \hline
 5187) \quad 41900 \\
 \quad \quad \quad 36309 \\
 \quad \quad \quad \hline
 5591 \text{ remains.}
 \end{array}$$

P R O B. IV.

Having given (in a Right-angled Triangle) any Two Sides, the Third may be found by the 47th of the first of Euclid, where 'tis demonstrated that the Square of the Hypothenuſe, viz. BC, is equal to the Sum of the Squares of AC and AB.

C A S E I.

Let ABC be a Right-angled Triangle, in which AB the Baſe equal to 24 Yards is given, and the Perpendicular AC, equal to 18 Yards; to find the Hypothenuſe BC.

R U L E.

Add the Square of the Baſe to the Square of the Perpendicular (of any Right-angled Triangle) and the Square Root of that Sum is the Hypothenuſe of the ſame Triangle.

E X.

E X A M P L E.

AB the Base=24

24

—

96

48

—

its Square 576

324

—

) 900 (30=BC the Hypothenufe required.

9

—

3) 000

AC the Perpendicular 18

18

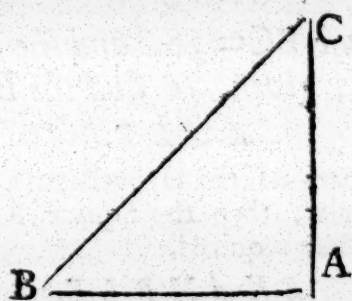
—

144

18

—

its Square 324



P R O B. V.

C A S E II.

Given the Hypothenufe BC=30, and the Base AB=24, to find the Perpendicular AC.

R U L E.

From the Square of the Hypothenufe subtract the Square of the Base, and the Remainder will be the Square of the Perpendicular, whose Square Root will be the Perpendicular it self.

E X-

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EXAMPLE.

The Hypothenufe 30

30

its Square 900

576

324 (18

1

28) 224

224

0

Answer, the Perpendicular AC is 18 Yards.

P R O B. VI.

CASE III.

The Hypothenufe BC=30, and the Perpendicular AC=18, given, to find the Base AB.

R U L E.

From the Square of the Hypothenufe, take the Square of the Perpendicular, then the Square Root of the Remainder, is the Base required.

EXAMPLE.

Hypothenufe BC=30

30

its Square 900

Squ. of the Perp. 324

Remains 576

4

44) 176

176

0

Perpendicular

18

18

144

18

324

its Square

(24 Root

Answer; 24 is the Length of the Base BA required.

P R O B.

P R O B. VII.

Given the slanting Side of a Pyramid or Cone, and also the Length of a Perpendicular let fall from the Vertex to the Center of the Base: To find the Diameter of the Base.

R U L E.

From the Square of the slanting Side, subtract the Square of the Perpendicular Line, then twice the Square Root of the Remainder is the Diameter of the Base required.

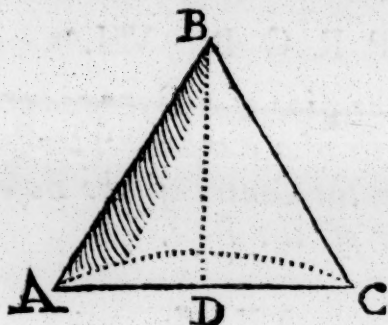
E X A M P L E.

Let the slanting Side be $AB=60$; which (because ABD is a Right-angled Triangle) may be called the Hypotenuse; and let the Perpendicular given be $BD=48$, to find $AD=\frac{1}{2} AC$.

$AB=60$	$BD=48$
<u>60</u>	<u>48</u>
<u>3600</u>	<u>384</u>
its Square	192
$BD's\ Squ\ 2304$	<u>2304</u>
Rem.) 1296	36 Root= $AD=\frac{1}{2} AC$.
9	therefore $AC=72$ requir'd.
<u>396</u>	
<u>396</u>	
0	

D

P R O B.



P R O B. VIII.

Given the Bung and Head Diameters (of a Cask, &c.) and also the Length, to find the Diagonal Line.

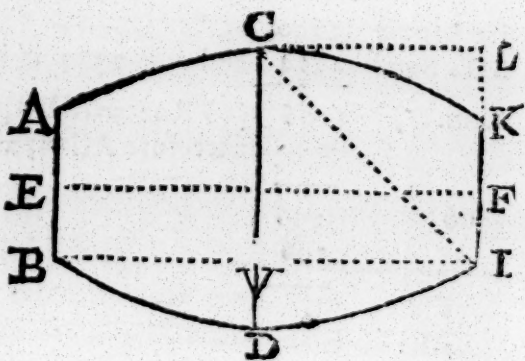
R U L E.

To the Square of Half the Sum of the Diameters, add the Square of Half the Length, then the Square Root of the Sum is the Diagonal Line required.

E X A M P L E.

Let the Head Diameter be $AB=IK=42$ Inches, the Bung Diameter $CD=49$ Inches, and the Length $EF=BI=34$; What is the Diagonal Line CI ?

Note, that $=$ signifies Equal to, and $+$ signifies to Add or More.



The

The half Difference between the Head KI, and Bung CD is LK, which if you add to the Head KI, the Sum will be the Leg. LI (of the Right-angled Triangle CLI) equal to Half the Sum of the Diameters, viz. CD+KI.

The length is EF=BI; Half of which is VI=CL, the other Leg. of the Right-angled Triangle CLI: By which you may find the Hypothenufe CI, according to the Case of *Prob. 4.*

LI=45.5 } Given, to find CI.
CL=27.

CL=27

LI=45.5

27

45.5

189

2275

54

2275

1820

CL □ 729

2070.25 LI □

729.

2799.25 (52.907 V.

25

101) 299

204

1049) 9525

9441

105807) 840000

740649

.99351

PROB. IX.

The Diameters and Diagonal given, to find the Length.

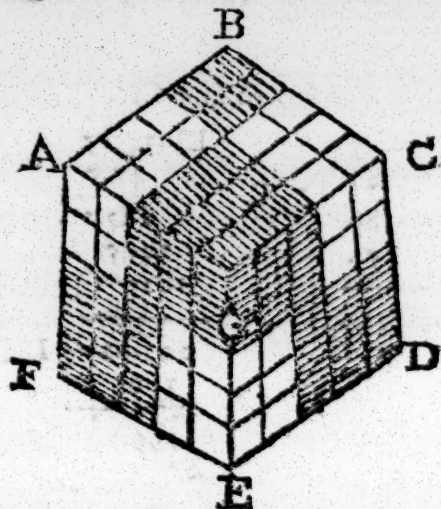
In this Problem you have IL, equal to half the Sum of the Diameters, and the Diagonal Line CI: to find CL, which will

D 2

will be equal to $VI = \frac{1}{2}$ the Length BI required, and may be found by *Prob. 5* or 6 foregoing.

To extract the Cube Root.

NOTE, that a Cube is a solid Body, contained under six equal Squares, as the Figure ABCDEFG.



A Cube Number is that which is made by multiplying any Number into it self, and that Product again by the Number given, and this last Product is the Cube of the Number so involv'd: So 125, 216, and 343 are the Cubes of 5, 6, and 7 produced as above, *i. e.*

Root=5	Root=6	Root=7
<u>5</u>	<u>6</u>	<u>7</u>
its Square = 25	its Square = 36	its Square = 49
<u>5</u>	<u>6</u>	<u>7</u>
its Cube = 125	its Cube = 216	its Cube = 343

By this you may know, that the Product of any Number in it self is called the Square of that Number; which Square,

Square, multiplied by its Root, produceth the Cube, or third Power of the same Number, &c.

To know of how many Figures the Root of any Cube doth consist, you must point every third Figure, beginning over Unity, and so many Points as you make, so many Figures you must expect in the Root.

What is the Cube Root of 12812904?

After having pointed every third Figure from Unity, 'twill stand thus, 128[.]12904[.], and because there are three Points over the given Cube; I must therefore expect that the Root should consist of three Places.

OPERATION.

The next greatest Cube to the first Point, or under 12, is 8, whose Root is 2: This 2 I must place in the Root or Quotient, and take its Cube, viz. 8 from 12, and the Work will stand thus,

$$\begin{array}{r} 12812904 \quad (2 \\ 8 \\ \hline \end{array}$$

To this 4 which remains 4 I bring down all to the next Point, and the Work will stand thus,

$$\begin{array}{r} 12812904 \quad (2 \\ 8 \\ \hline \end{array}$$

And the Resolvend is 4812

Now for a Divisor, I must square the Quotient or Root 2, and that will be 4; which multiplied by 300, is 1200; to which add the Rectangle of the Root 2 in 30, and the Sum will be 1260, for a Divisor.

Where, Note, that the Divisor is always found by multiplying the Square of the Quotient by 300, and adding that to the Product of the Quotient it self in 30, as above and hereafter may be seen.

D 3

This

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This Divisor, viz. 1260, I find may be had 3 times in 4812
 for 3 in 1200 (the Square of the Quotient in 300) is 3600
 and 9 (the Square of the Root 3) in 60 is 540
 to which add the Cube of 3, viz. 27
 and the Sum is 4167
 which take from 4812, and there will remain 645 as below.

$$\begin{array}{r}
 \cdot \cdot \cdot (23 \\
 12812904 \\
 \underline{8} \\
 4812 \\
 \underline{4167} \\
 \hline
 \end{array}$$

Remains 645

To this Remainder I bring down all to the next Point,
 and 'twill stand thus;

$$\begin{array}{r}
 \cdot \cdot \cdot (23 \\
 12812904 \\
 \underline{8} \\
 4812 \\
 \underline{4167} \\
 \hline
 \end{array}$$

for a Resolvend

645904

Again, (as before) I square the Quotient or Root, viz. 23, and that is 529, which Square must be multiplied by 300, and the Quotient it self by 30; then the Sum of these two Products is 159390, for a Divisor; which (by Tryals) I find I may have 4 Times in the Resolvend 645904; therefore as (above)

$$529 \times 300 \times 4 =$$

$$\text{and } 23 \times 30 \times 16 =$$

$$\text{to which add the Cube of } 4 =$$

and the Sum is

$$634800$$

$$11040$$

$$64$$

$$\begin{array}{r}
 645904 \\
 \hline
 \text{which}
 \end{array}$$

which take from the last Resolvend, and the Remainder will be 0, and appear as below.

$$\begin{array}{r}
 12812904 \quad (234 \\
 \underline{8} \\
 4812 \\
 \underline{4167} \\
 645904 \\
 \underline{645904} \\
 0
 \end{array}$$

Where also note, that because nothing remains, the Number given was a true Cube Number.

But if any thing had remain'd, you should have set 3 Cyphers on the right Side of the Remainder, and then proceed to find the next Figure to put in the Quotient, as before: Where you must also note, that for every three Cyphers which you make use of this way, you will have one decimal Place in the Root. But before you begin to extract the Cube Root of any Number, you may set 3, 6, 9, or 12 Cyphers on the right Side of it, and point all as above directed, and then proceed to find the Root, as in the Example following.

Let

Let it be required to extract the Cube Root of
427362

427362,000000000000 (75,3237 Root.
343

84362

78875

7487000

5082777

404223000

340295768

63927232000

51059955267

12867276733000

11914574816053

952701916947 Remains.

If the Number given, to have its Cube-Root extracted, has any Number of decimal Places, that are not 3, 6, 9, or 12, &c. you must make them so by placing Cyphers on the right Side, and then point them beginning as in whole Numbers.

The Use of the Cube Root.

The Diameter and Weight of a Bullet given, to find the Weight of another Bullet, whose Diameter is also given.

This is answered from the Prop. 18. of the 12th Book of Euclid; from whence may be drawn the Proportion following, i. e.

As

As the Cube of the Diameter of the given Sphere or Bullet, is to the Cube of the Diameter of any other Sphere or Bullet, so is the Weight of that given Bullet, &c. to the Weight of the other requir'd.

E X A M P L E.

There is a Bullet whose Diameter is 4 Inches, and its Weight 9 Pounds: I demand the Weight of another Bullet, whose Diameter is 7,5 Inches.

the Cube of 4 is 64

and the Cube of 7,5 is 421,875

Then say as 64 : 421,875 :: 9l. : 59,3261 l. thus,

$$\begin{array}{r}
 \begin{array}{r}
 9 \\
 \hline
 64 \quad 3796,875 \quad (59,326 \text{ Answer} \\
 \hline
 320 \\
 \hline
 596 \\
 576 \\
 \hline
 208 \\
 192 \\
 \hline
 167 \\
 128 \\
 \hline
 395 \\
 384 \\
 \hline
 11
 \end{array}
 \end{array}$$

P R O B.

PROB. I.

There is a Conical Tun, whose Bottom Diameter is 40 Inches, the Diameter at the Top is 30 Inches, and the Depth is 20: According to which 'twill contain 68,7 Beer Gallons. I would know the Diameters and Depth of another Conical Tun, which will hold 90 Gallons of Beer.

The Solution of this Problem may be taken from *Prop. 36. Lib. Mathes. Enuil.* where 'tis demonstrated that similar or like solid Figures, are to one another in triplicate Proportion of their Homologous Sides, *i. e.* as the Cubes of their like Sides.

R U L E.

From the above-mentioned *Prop.* we may infer the Proposition following, *viz.*

As the Content of the given Tun, *viz.* 68,7 is to the Cube of 40 (the bottom Diameter) = 64000; so is 90 the Content of the required Tun, to 83842,794; which is the Cube of the bottom Diameter of that Tun whose Content is 90, and the Cube Root thereof is 43,77 the Diameter required.

Again, for the top Diameter say,

As the Content of the Tun given, *viz.* 68,7 is to the Cube of its top Diameter, *viz.* 30; so is 90 the Content of the other Tun, to the Cube of its top Diameter, whose Cube Root is 32,82.

Lastly; for the Depth say,

As 68,7 is to the Cube of its Depth, (*viz.* the Cube of 20) so is 90 the Content of the other Tun to the Cube of its Depth; whose Cube Root is 21,88, the Depth required: To prove which you now have the Diameters and

and Depth of a Conical Tun; which by the Rules following, you'll find will contain near 90 Gallons, and the like of any other such Figure.

To calculate Diagonal Tables or Lines for Casks, taken as the middle Frustum of a Spheroid.

By Prob. 8. of the Square Root find the Diagonal thus; let the Bung Diameter be 26 Inches, the Head 20, and Length 24: What's the Content and Diagonal?

Bung 26 Head 20 Sum 46 $\frac{1}{2}$ the Sum 23 23 69 46 its Square 529 144 673,00 (25,94 Diagonal of the Cask. 4 45) 273 225 509) 4800 4581 5184) 21900 20736 1164	Length 24 $\frac{1}{2}$ the Length 12 12 its Square 144
--	--

The Content of the Vessel is 39 Beer Gallons.

Having

Having by the Bung, Head, and Length, above given, found these two Requisites, *viz.* the Content of the Cask and its Diagonal, you may find the Diagonal Line of any other Cask, whose Content is given by the Proportion following, *viz.* as 39 is to 17454.6, so is 1, 2, 3, 4, 5, 6, 7, &c. the Contents of another Spheroidal Cask to the Cube of their Diagonals, whose Cube Roots will be the Diagonals for the Contents given; which you may collect into a Table or project upon an Instrument, as occasion requires. But here, note, that though I shall give one Example here, and perform it according to decimal Arithmetick, for Order's Sake, yet this Sort of Work may be best managed by the Logarithms, as you may see in *Mr. Marmaduke Hodgefon's Book of Gauging, Pag, 67, 68.*

E X A M P L E.

Let it be required to find the Length of the Diagonal Line of that spheroidal Cask, whose Content is 20 Gallons.

Say, as 39 the Content of a spheroidal Cask, is to the Cube of its Diagonal Line, 17454.6; so is 20 the Content of another such Cask, to 8951, the Cube of its Diagonal, whose Cube Root is, 20.7 the Answer.

By this you may know, that if you let fall a Rule (having only a Line of Inches on it) Diagonal-wise from the Bung, and find that the Length of that Line is 20.7 Inches, that the Content of that Cask is 20 Beer Gallons.

This may be better understood, and done with much more Expedition when I come to speak of the Sliding-Rule. And here note, that to find the Side of a Cube which shall be equal in Content to any given Solid, is only to extract the Cube Root of the Content of that Solid, whether it be a Cone, Sphere, or Cylinder, &c.

The Rule of THREE.

I Need not go about to define this Rule, since the very Name is a sufficient Definition: However, some Questions proper to it are as follow.

PROB. I.

c. *l.* *s.* *l.*
If 42 cost 172 : 16 : what will 47 cost?
112 172,8 in a decimal Way.

224	47
448	12096
4704	6912

4704) 8121,6000 (1,7265, i. e. by Reduction.
4704

34176	<i>l.</i> <i>s.</i> <i>d.</i> <i>q.</i>
32928	1 : 14 : 6 : 1,44 the Answer

12480
9408

30720
28124

24960
23520

1440

If the Duty of 16 Bushels of Malt be 8 Shillings; what is the Duty of 732 at that Rate?

B. l. B.
If 16 : 4 : : 732

4

16) 292,8 (18,3, i. e. 18 : 6 : 00. for Answer.
134(0
00

If the Duty of 32 Barrels of X Beer be worth

l. s.

7 : : 12. what's the Duty of 72,56 Barrels?

B. l. s. l. B.
If 32 give 7 : 12, i. e. 7,6; what will 72,56 give?

7,6

43536
50792

32) 551,456 (17,233
23709(0
010(0
l. s. d. q. l.

Ans. 17,233; which by Reduction is 17 : 4 : 7 3, 68

If the Salary of an Officer be 48,5 *per Annum*, what must be paid him for 232 Days?

If

d. *l.*
If 365 give 48,5; what will 232 Days?

$$\begin{array}{r}
 232 \\
 \hline
 970 \\
 1455 \\
 970 \\
 \hline
 365) 11252,000 \quad (30,827, \text{ answer, } i. e. \\
 1095 \\
 \hline
 3020 \quad l. \quad s. \quad d. \quad q. \\
 2920 \quad 30 : 16 : 6 : 1,92 \\
 \hline
 1000 \\
 730 \\
 2700 \\
 2555 \\
 \hline
 145
 \end{array}$$

If the Duty of 172 Bushels of Malt be

l. *s.* *l.*
4 : 6. *i. e.* 4,3; what will the Duty of 92 Bushels be?

B. *l.* *B.*
If 172 give 4,3; what will 92 give?

$$\begin{array}{r}
 92 \\
 \hline
 86 \\
 387 \\
 \hline
 172) 395,6 \quad l. \quad l. \quad s. \\
 344 \quad (2,3. \quad i. e. \quad 2 : 6. \text{ for Answer.} \\
 \hline
 516 \\
 516 \\
 \hline
 0
 \end{array}$$

The General Gauger.

l. s. l.

If the Duty of 92 Bushels of Malt be 2 : 6. i. e. 2,3;
what is the Duty of 172 Bushels?

B. l. B.

If 92 give 2,3; what will 172 give?

$$\begin{array}{r}
 2,3 \\
 \hline
 516 \\
 344 \\
 \hline
 92 \overline{) 395,6} \quad (4,3 \text{ ans. i. e. } 4 : 06: \\
 \underline{270} \\
 10
 \end{array}$$

If the Interest of 100 Pounds be 5*l.* per Annum; what
may I demand for the Use of 45*l.* : 18*s.* : i. e. 45,9*l.*
for one Year at that Rate?

l. int. l.

If 100 give 5; what 45,9

$$\begin{array}{r}
 5 \\
 \hline
 100 \overline{) 229,5} \quad (2,295, \text{ i. e. } 2 : 05 : 10 : 3,2 \\
 \underline{200} \\
 295 \\
 \underline{200} \\
 95
 \end{array}$$

l. s. d. q.

Answer 2 : 05 : 10 : 3,2

*Having the Diameters and Depth of a Conical
Tun; To find the Depth or Height of the
whole Cone, of which such a Tun is a Fru-
stum.*

EXAMPLE.

Let ABCD be the Frustum of a Cone, and let the Dia-
meter at the Base AB be 40 Inches; that at the Top
CD=35. and let the Depth OP be 27: I demand the
Height of a Cone, viz. ON, the Distance of the Vertex
N, from the Center of the Base O.

RULE.

The General Gauger.

41

R U L E.

Say, as Half the Difference of the Diameters DC, and AB, *i. e.* A *d* or B *c* is to the Depth of the Fruustum *c d* or D *c*: So is Half the Diameter of the Base AB, *i. e.* AO=BO; to the Height of the whole Cone NO.

	<i>in.</i>
Greatest Diameter	40
Least Diameter	35
Difference	5
Half the Difference	2,5
Half the Base AB is 20; then say,	

$$Ad : Cd :: AO : NO.$$

$$As 2,5 : 27 :: 20 : 216.$$

20

$$\begin{array}{r} 2,5 \overline{) 540,0} \\ \underline{045} 0 \\ 10 \end{array} \quad (216, \text{ answer, } i. e. \text{ NO the Height requir'd.})$$

Here you may note, that the Triangles A, N, O, and A, C, *d*, are Similar, and therefore the Proportion preceding is grounded upon *Prop. 4th of Euclid 6* where 'tis demonstrated, that the Sides of Equiangular Triangles are Proportional.

Having the Height of a Cone, and the Diameter of its Base, to find the Diameter at any Depth.

The Solution of this *Problem* depends upon the same Geometrical Principle with the last; and consequently may have the same Figure to inform the Mind.

E X A M P L E.

Let the Height be NO=216 Inches, and the Diameter AB=40; to find the Diameter CD at 27 Inches from the Base AB.

E 5

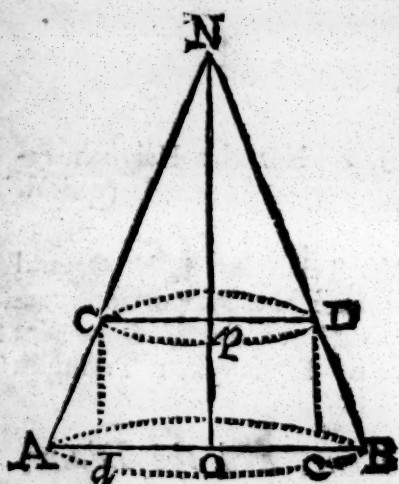
3. Take

The General Gauger.

1. Take $27 = c d = p o$, out of $NO = 216$, and there will remain 189 , the Side Np of the right-angled Triangle NCp .

2. Say, as the Side $NO = 216$, is to half the Diameter $AO = 20$, so is $Np = 189$, to $Cp = 17,5$, which is half the Diameter CD ; which double gives $35 = CD$, the Diameter requir'd.

By the last Example you may find the Diameter at every 5 or 10 Inches Depth of any Conical Tun; and this will be of great Use in the Practice of Gauging.



$NO = 216$
 $CD = 35$
 $AB = 40$
 $Ad = Bc = 2,5$
 $Cd = Dc = p o = 27$
 $Np = 189$.

Having the Diameter of a Circle to find its Circumference.

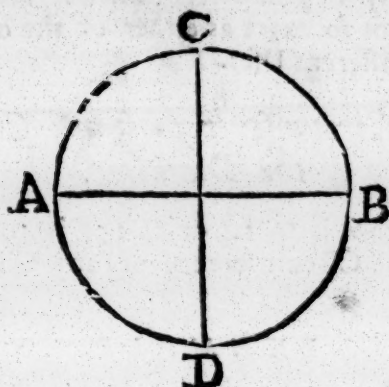
RULE.

Say, as 1 is to 3,1416, or as 113 to 355, or as 7 is to 22; so is the Diameter to the Circumference,

EXAMPLE.

Let the Diameter AB of the Circle $ABCD$, be 32 Inches, what's the Circumference?

1. As



1. As 1 : 3,1416 :: 32

$$\begin{array}{r} 32 \\ \hline 62832 \\ 94248 \end{array}$$

Facit 100,5312, by the first Way.

2. As 113 : 355 :: 32

$$\begin{array}{r} 32 \\ \hline 710 \\ 1065 \end{array}$$

113) 11360,0000 (100,5309, by the second Way.
 00060510(3
 006311(8
 0001(0

3. As 7 : 22 :: 32

$$\begin{array}{r} 22 \\ \hline 64 \\ 64 \end{array}$$

7) 704,0000 (100,5714, by the third Way.
 004513(2

This

The General Gauger.

This last Way I would recommend, being easy to remember, yet not so exact as either of the other, but near enough for indifferent Uses.

Having the Circumference of any Circle to find the Diameter.

Say, as 3,1416 is to 1, or as 355 is to 113, or as 22 is to 7, so is the Circumference of any Circle to its Diameter.

E X A M P L E.

Let the Circumference be 97 Inches, what's the Diameter?

$$\begin{array}{r}
 1. \text{ As } 3,1416 : 1 :: 97 \\
 3,1416 \overline{) 97,000000} \quad (30,875 \text{ Diam. requir'd, first Way.} \\
 \underline{02752028(0} \\
 275270(0 \\
 \underline{2388(0} \\
 18(1 \\
 (3
 \end{array}$$

$$2. \text{ As } 355 : 113 :: 97$$

$$\begin{array}{r}
 \underline{97} \\
 791 \\
 \underline{1017} \\
 355 \overline{) 10961,000} \quad (30,876 \text{ Diam. the second Way.} \\
 \underline{031105(0} \\
 3171(2 \\
 \underline{22(0}
 \end{array}$$

$$3. \text{ As } 22 : 7 :: 97$$

$$\begin{array}{r}
 \underline{7} \\
 22 \overline{) 679,000} \quad (30,863 \text{ Diam. the 3d Way.} \\
 \underline{01948(4} \\
 110(1
 \end{array}$$

Ta

EXAMPLE.

Let the Gross be 20 Bushels, the Neat 16, and the Duty 8 Shillings; that is, $\frac{1}{4}$ of a Pound Sterling, which divide by 20, the Gross 20) 50 (02 is the Multiplier
(00

The Use of the Sliding Rule.

The Ingenious Mr. *Everard* has sufficiently handled this Subject, therefore I might have saved my self that Trouble; but because 'twill be expected, and the Book more useful, I shall say something to that Purpose, and begin first with

NUMERATION upon the Lines.

Numeration by these Lines may be understood by this one Thought, viz. That what Denomination so ever the 1 at the Beginning of the Line is, that in the Middle will be ten Times, and that at the End will represent an hundred Times so many; which, if understood, 'tis not hard to know what the intermediate Figures and Parts are.

EXAMPLE.

To find the Place of 25. you may call the 1, at the Beginning of the Lines but 1, then will that in the Middle be 10, and the 2 which stands upon the second Radius, will be 20; then count five of the grand Divisions; where stop, for that is the Place which represents 25. Where note, that if you had esteemed the 1 at the Beginning of the Line but 1, that is, one Tenth, the Place which now represents 25. would then signify but 2.5; also, if you had esteemed it as 10, then would the Place

of 25. be 250; if 100, then 2500; if but .01, then but .25, &c.

EXAMPLE II.

Find upon the Line A or B, the Place of 3652.

First, esteem the 1 at the Beginning of either Line to be 100, then will that on the Middle be 1000, and the 3, which is on the second *Radius* is 3000; from which count 6 of the grand Divisions and a Half (towards 4000) and then you'll come to the Place of 3650. Now you must imagine the 2 to be a little beyond that half Division; (for in this and the like Examples, where we are to find 4 Places, that which is Units must be taken by Estimation) so have you the Place of 3652.

EXAMPLE III.

Find upon the same Lines the Place of 15737.

First esteem the 1 at the Beginning of the Line to be 1000, then will that in the Middle be 10000, and 5 of the grand Divisions will be 5000, *i.e.* 15000; then is 3 and Half of the intermediate Divisions the Place of 700, *i.e.* 15700: And as for the Place of 37, you must by Estimation take it a little farther forward. So will you come to the Places 15737: But here you are to note that you can't exactly find the Place of any Number which exceeds 4 Places; and in many Cases you will not be sure of the 4th Place. However, what has been said is sufficient to explain Numeration.

MULTIPLICATION by the Lines.

This Rule (whether to be perform'd Arithmetically or Instrumentally) depends upon *Euclid's Elements, Prop. 1. Lib. 2*; where 'tis demonstrated, that if two Lines be propos'd, whereof one is divided into diverse Parts, the Rectangle contained under those two Lines, is equal to the

the Rectangles contained under the Line which is not divided, and the Parts of the Line divided.

The Proportion is, as 1 is to the Multiplier; so is the Multiplicand to the Product.

EXAMPLE.

Let it be requir'd to multiply 26 by 9.

RULE.

Set 1 (upon the Line B.) to 9 upon A; then against 26 upon B, is 234, the Product sought upon A. Where note, that when the Product consists of three Places, the Rule will inform you what two Figures should possess the Places of Tens and Hundreds, but what should possess the Place of Units will sometimes be doubtful; therefore, that they may be always certain what that Figure should be, you may in your Mind multiply the unit Figure of the Multiplier by that of the Multiplicand, as above. I multiply 6 by 9, and the Product is 54; by which I know the 4 will possess the Units Place of the Product.

EXAMPLE II.

Let it be required to find the Product of 72 in 26.

RULE.

Set 1 upon B. to 26 upon A; then against 72 on B is 1872 upon A; and such is the Rectangle of 26 in 72.

It sometimes seems doubtful how many Figures should be in the Product; to remedy which take the Rule following.

RULE.

Observe how many Figures above Units are in the Multiplicand, and how many in the Multiplier; then for every

every one as there is in both, (above Units) reckon one in the Product; and for the Units in both, reckon one more. And lastly, if the Multiplicand is found against the Product in the same *Radius* on which the Multiplier was, you'll have no more Places than you had by your former Account. But if it falleth beyond that *Radius*, you must account (for that) one Place more; as in the last Example, for the 2, I reckon 1, and for the 7, 1, *i. e.* 2. then the 2 in 72, and 6 in 26, are both in the Place of Units, for which I reckon one more, *i. e.* 3; then when my Rule is set, *i. e.* when I set 1 on B, to 26 on the first *Radius* of the Line A, I find 72 upon B will not fall upon the same *Radius*, on which 26 is, but the next beyond; for which I reckon another Place in the Product, which add to the 3 as before found, and the Sum, *viz.* 4, will inform me, that the Product will consist of 4 Places, *viz.* 1872, as above.

DIVISION by the Lines.

In Division, the Quotient contains Unity as often as the Dividend does the Divisor: It follows then from the 5th Definition to the 5th Book of *Euclid's Elements*, that the Quotient is in Proportion to 1, as the Dividend is to the Divisor; from whence then we may also deduce the Proportion following, *viz.* as the Divisor is to 1, so is the Dividend to the Quotient.

E X A M P L E.

Divide 336 by 12:

R U L E.

Set 12 upon B, to 1 upon A; then against 336 upon B, you'll find 28 upon A; which is the Quotient required.

You'll know how many Figures should be in the Quotient, by setting the Divisor orderly under the Dividend, &c.

F

E X-

EXAMPLE I.

Divide 48627 by 96.

R U L E.

Set 96 upon B, to 1 upon A; then against 48627 on B, you have 506,53 the Quotient required upon A. So

if $\left\{ \begin{array}{l} 26 \\ 48 \\ 96 \end{array} \right\}$ were given to be divided by 6, you'll find $\left\{ \begin{array}{l} 4.33, \text{ \&c.} \\ 8. \\ 16. \end{array} \right\}$ the Quotients to be

REDUCTION of Decimals by the Rule.

Let this vulgar Fraction, viz. $\frac{3}{4}$. be given to be reduced unto a Decimal.

R U L E.

As the Denominator 4, is to its Numerator 3, so is 1.00 the decimal Denominator to .75 the decimal Numerator: Which is the Decimal of $\frac{3}{4}$: Where note, that every Decimal will be as little in Respect of 1, as the Numerator is in Respect of the Denominator of its vulgar Fraction. Set 4 upon B, to 1 upon A. then against 3 upon B, is .75 on A; and that is the Decimal of $\frac{3}{4}$: For as 3 the Numerator is to 4 its Denominator, so is .75 a decimal Numerator to 100, its Denominator, &c.

EXAMPLE II.

What's the Decimal of 18 Shillings making a Pound Sterling the Integer?

The vulgar Fraction is $\frac{18}{20}$; therefore set 20 upon B, to 1 upon the Line A, then against 18 on B, is .9 on A; which is the Decimal required.

EXAMPLE III.

What decimal Part of a Barrel is 12 Gallons? The vulgar Fraction is $\frac{12}{34}$; therefore set 34 upon B, to 1 upon

on A; then against 12 on B, is ,35, &c. on A; which is the Decimal of 12 Gallons required.

To find the Value of the Decimal of a Pound Sterling.

E X A M P L E. I.

What is the Value of ,27 of a Pound Sterling?

1. Set 1 upon B, to 20 upon A; then against ,27 on B, is 5,4 on A, *i. e.* 5 Shillings, 4 Tenth.

2. Set 1 upon B to 12 upon A; and then against 4 on B, you'll find 4,8 on A, *i. e.* 4 Pence, and 8 Tenth of a Penny.

3. Set 1 upon B to 4 upon A; then against 8 on B is 3,2 on A, *i. e.* 3 Farthings, and ,2 of a Farthing. And thus by the Rule you find, that the Value of ,27 of a Pound Sterling, is 5 Shillings 4 Pence 3 Farthings, and ,2 of another.

E X A M P L E II.

What is the Value of ,62 of a Barrel of Beer?

1. Set 1 upon B, to ,62 upon A; then against 4 upon B, is 248 on A, from which (according to Multiplication) cut off two Places, and then 'tis 2,48, *i. e.* 2 Firkins, and ,48 Parts.

2. Set 1 upon B, to ,48 on A; then against 8,5 on B, is 4080 on A, from which cut off three Places, and then 'twill be 4,080, *i. e.* 4 Gallons and ,080 of a Gallon.

F. Gall.

So the Value of ,61 of a Barrel of Beer is 2 : 4 : 08. And according to this Method may the Value of any Decimal be found, either in Weight, Measure, Money, or Time, to a very inconsiderable Matter.

The Rule of THREE by the Lines.

The Rule of Three by the Lines must be perform'd by the Method following: *viz.*

Set the First Number on B, to the second on A, then against the third Number on the Line B, you'll have the fourth required on A.

EXAMPLE I.

If the Duty of 16 Bushels of Malt be 8 Shillings; what's the Duty of 47 Bushels at that Rate?

OPERATION.

Set 16 upon B, to 8 upon A; then against 47 on B, you'll find 23,5 on A, *i. e.* 23 Shillings 6 Pence, the Answer.

EXAMPLE II.

If the Proportion to find the Circumference of a Circle be as 113, to 355; I demand the Circumference of a Circle, whose Diameter is 26.

OPERATION.

Set 113 upon B, to 355 upon A; then against any Diameter on B, you'll have its Circumference on A: So against 26 on B, you have 81,68 on A, the Circumference required.

EXAMPLE III.

Having the Circumference of a Circle to find the Diameter, the Proportion is as 355 to 113; so is any Circumference to its Diameter.

Let the Circumference be 96, what's the Diameter?

OPERATION.

Set 355 upon B, to 113 on A; then against any Circumference upon the Line B, you'll have its Diameter

on

on A ; so against 96 on B, you'll find 30,5 on A, the Diameter required.

E X A M P L E IV.

The Proportion between Beer and Wine, is as 9 to 11.

Suppose by the following Rules, that I found a Vessel to contain 42 Gallons of Beer; I demand how many Gallons of Wine the same will hold.

O P E R A T I O N.

Set 9 upon B, to 11 upon A; then against 42 on B, you'll find 51,33, *i. e.* 51 Gallons, 33 Parts of Wine on A, the Answer.

To find the Area of a Circle in Beer and Wine Gallons, and Malt Bushels.

R U L E.

Say, as the Gauge Point (proper to that Denomination in which you'll find the Area) on the Line D, is to 1 on C; so is any Diameter on D, to its Area on C.

E X A M P L E.

There is a Circle, whose Diameter is 56 Inches; what is the Area in Beer and Wine Gallons, and Malt Bushels?

For Beer, set the Gauge Point, *viz.* 18,95, marked with AG, on the Line D, to 1 on C; then against 56 on D, you'll find 8,73 on C, and as the Rule is now set, it may serve as a Table of Circles Areas; for against any Diameter on D, you'll find its Area on C.

For Wine, set the Gauge Point, *viz.* 17,15, (mark'd with WG) on the Line D, to 1 on C; then against 56 on D, you'll find 10,666 on C, the Area requir'd.

For Malt, set the Gauge Point, viz. 52,32 (mark'd with MB) on D, to 1 on C; then against 56 on D, you'll find 1,145, on C, the Area requir'd. Here note, that if you'd have $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{3}{4}$, &c. of the Area of a Circle, you must set the Gauge Point, to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{3}{4}$, &c. of 1, and then against the Diameter you'll find the like Part of its Area.

To extract the Square-Root by the Rule.

This Rule is grounded upon the 4th *Prop.* of the 2d Book of *Euclid's Elements*, but may be performed thus: Set those Lines, which are noted with the Letters C and D, even; i. e. set 10 at the End of the Line D, to 10 which is at the End of the Line C; then these two Lines will be as a Table of Squares and their Roots; for against any Square on the Line C, you'll have its Root on D.

When note, That when the Figures in the Number given are even, i. e. when they consist of 2, 4, 6, or 8 Figures, (being Integers,) look the same in the second *Radius* of the Line C, and against it you'll have the Square Root thereof on the Line D.

E X A M P L E.

Let 64 be given to have its Square Root extracted.

R U L E.

Having set the Lines C and D even, find 64 in the second *Radius* of the Line C, and against it upon D, you'll find 8, the Square Root requir'd.

In like manner as the Rule now stands, you'll find that

$\left. \begin{array}{c} 4 \\ 5 \\ 6 \\ 7 \end{array} \right\}$

are the Square Roots of

$\left. \begin{array}{c} 16 \\ 25 \\ 36 \\ 49 \end{array} \right\}$

When

When the Integers in the Number given are odd, as consisting of, 1, 3, 5, 7, or 9 Places, you must find it in the first *Radius* of the Line C, and against it you'll have the Root required on the Line D.

E X A M P L E.

Let 144 be given to have its Square Root extracted.

O P E R A T I O N.

Find 144 upon the first *Radius* of the Line C, and against it on the Line D, you'll have 12, the Root required.

So will $\left\{ \begin{array}{l} 14,2 \\ 2,5 \\ 10. \end{array} \right\}$ be the Square Roots of $\left\{ \begin{array}{l} 201.64 \\ 6,25 \\ 100, \end{array} \right\}$

To know of how many Places the Root will consist, you may (before you handle the Sliding Rule) point the Square given, as is before directed.

The Use of the Square Root by the Sliding Rule.

P R O B. I.

To find a mean Proportional between any two given Numbers.

R U L E.

Set either of the two given Numbers upon C, to the same on D; then against the other Number given on C, you'll find the Mean requir'd on D.

E X-

EXAMPLE.

Find a mean Proportional between 64 and 156.

OPERATION.

Set 64 upon the Line C, to 64 on D; and then against 256 on C, you'll have 128, the Mean required on D.

PROB. II.

Given the Conjugate and Transverse Diameters of an Oval, to find the Diameter of a Circle, which shall be equal to the Oval in Area.

EXAMPLE.

Let the Conjugate Diameter of the Oval be 52,5, and the Transverse 210.

OPERATION.

Set 52,5 upon the Line C, to 52,5 upon the Line D; then against 210 upon C, you'll have 105 on D, which is the Diameter requir'd.

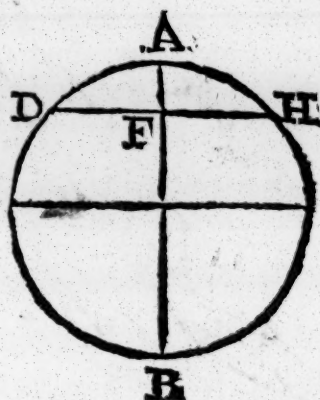
PROB. III.

Given AB the Diameter of a Circle, and AF, the versed Sine of its Segment, to find DH the Chord Line. Let AB be 46 Inches, and AF, 8; (DF is a mean Proportional between AF and BF by the 13th of Euclid the 6th.)

OPERATION.

Set 8 upon C, to 8 upon D; then against $38=BF$ on C,

C, you'll have $17.43 = DF$, on D; which doubled, gives DH the Chord Line requir'd, which is 34,86 Inches.



To extract the Cube Root by the Lines E and D.

GENERAL RULE.

Place the two Lines, viz. E and D, even; i. e. place 1 at the Beginning of E, to 1 at the Beginning of D, then against any Cube upon the Line E, you'll have its Root up; on the Line D.

EXAMPLE I.

What's the Cube Root of 1728? Set the Rule even as above directed, then find 1728 upon the Line E, and against that on the Line D, you'll find 12, the Cube Root required.

EXAMPLE II.

What's the Cube Root of 6592? Set the Rule, and against 6592, upon the Line E, you'll find 18,75 upon the Line D, which is the Cube Root required.

Here

Here note, That when the Integers in the given Cube consist of 1, 4, or 7 Places, you must find it in the first *Radius* of the Line E; if of 2, 5, or 8, in the second *Radius* of the Line E: But if of 3, 6, or 9 Places, then in the third *Radius* of the same Line. And here also you must point your Cube, as by the Pen you were before taught, to know the Number of Places in the Root.

The Use of the Cube Root by the Sliding Rule.

P R O B. I.

There is a Bullet whose Diameter is 4 Inches, and Weight 9 Pounds; what is the Weight of another Bullet, whose Diameter is 16 Inches?

R U L E.

Set 4, the Diameter given, on the Line D; to 9l. the Weight of that Bullet upon the Line E; then against 16 upon the Line D, you'll find 576 upon the Line E; and that is the Weight of the Bullet required.

P R O B. II.

There is a Bullet whose Diameter is 8 Inches, and Weight 72 Pounds; I demand the Weight of another Bullet (of the same Metal) whose Diameter is 4 Inches.

R U L E.

Set 8 (the given Diameter) upon D, to 72 the Weight of its Bullet on E; then against 4 upon D, you'll find 9 upon

upon E, the Weight required. And, as the Rule now stands, you may find the Weight of all Bullets of that Metal; for against the Diameters upon D, you'll have the Weight on E.

Thus, if the Diameter of a Bullet be $\left. \begin{matrix} 3 \\ 5 \\ 6 \\ 7 \end{matrix} \right\}$ Inches, the Weight will be $\left. \begin{matrix} 3,79 \\ 17,57 \\ 30,37 \\ 48,23 \end{matrix} \right\} l.$

P R O B. III.

Having the Diagonal Line of a Cask taken as the middle Frustum of a Spheroid in Inches, to find the Content thereof in Beer Gallons.

R U L E.

Set 22,93 upon the Line D, to 27 upon the Line E; then against the Diagonal of any spheroidal Cask upon D, you'll have the Content thereof upon the Line E, in Beer Gallons.

E X A M P L E.

Let the Diagonal of a Cask be 20 Inches; I demand the Content thereof in Beer Gallons.

O P E R A T I O N.

Set 22,93 upon D, to 27 upon the Line E, then against 20 (the given Diagonal) upon D, you'll find 17,91 upon E, and that is the Content required. And as the Rule now stands, you'll find, that if the Diagonal Line in Inches of any such Vessel

be $\left\{ \begin{matrix} 12. \\ 22,93 \\ 48,59 \end{matrix} \right\}$ The Content thereof in Beer Gallons will be $\left\{ \begin{matrix} 3,86 \\ 27. \\ 257. \end{matrix} \right\}$

The

The foregoing Examples depend on the same Principle, on which I signified the former Problems in the Use of the Cube Root Arithmetically did: *i. e.* that like Solids are in triplicate Proportion of their Homologous Sides; and on the same depend those which follow.

P R O B. IV.

Having the Diagonal of a Vessel in Inches, to find the Content thereof in Wine Gallons.

R U L E.

Set 15,9 upon D, to 11 upon E, and then against any Diagonal Line in Inches upon D, you'll have the Content of the Vessel on E, in Wine Gallons.

E X A M P L E I.

Let the Diagonal of a Cask in Inches be 50,49; I demand the Content in Wine Gallons.

O P E R A T I O N.

Set 15,9 upon D, to 11 upon E; then against 50,49 upon D, you'll have 352 upon E; and such is the Content required in Wine Gallons.

E X A M P L E II.

Suppose the given Diagonal was 9,01; I demand the Content in Wine Gallons.

O P E R A T I O N.

Set 15,9 upon D, to 11 upon the first *Radius* of the Line E, then against 9,01 (the given Diagonal) on D, you'll find 2, upon the Line E, for the Content of the Vessel in Wine Gallons.

The two last Problems will be of great Use where a four Foot Rule is not at Hand, to find the Content of
Casks

Casks (if upon the Sliding Rule you have the Lines E and D projected) only by knowing the Length of the Diagonal Line in Inches. But instead of these Lines, there's now commonly inserted a Line of Numbers and Segments for a standing Cask, of which I shall speak in its proper Place; but these are not (in my Opinion) so necessary as the other.

P R O B. V.

There is a Conical Tun, whose Diameter at the Top is 20 Inches, that of the Bottom 26 Inches, and the Depth 30: By which the Content (in Ale Gallons) appears to be 44,45: I demand the Diameter at the Top, the Diameter at the Bottom, and the Depth of another Conical Tun, whose Content is 88,9 Gallons.

O P E R A T I O N.

1. To find the Diameter at the Top.

Set 44,45 upon E, to 20 upon the Line D; then against 88,9 upon E, you'll find 25,2, the Top Diameter required.

2. To find the Bottom Diameter.

Set 44,45 upon E, to 26 upon the Line D; then against 8,89 upon E, you'll find 32,75, the Bottom Diameter required on D.

For the Depth of the Conical Tun, whose Content is 88,9.

Set 44,45 upon the Line E, to 30 upon the Line D, then against 88,9 on E, you'll find 37,79, the Depth required upon D.

G

P R O B.

P R O B. VI.

There is a Cask whose Bung Diameter is 20 Inches, its Head Diameter is 14, and the Length 24; by which the Content appears to be 22,19 Beer Gallons; I demand the Bung, Head, and Length of another such Vessel, whose Content is 40 Gallons.

O P E R A T I O N.

1. To find the Bung Diameter.

Set 22,19 upon E, to 20 upon D; then against 40 upon E, is 24,34, the Bung Diameter required.

2. To find the Head-Diameter.

Set 22,19 upon E, to 14 upon D; then against 40 upon E, you'll find 17,03 upon D, for the Head Diameter required.

3. To find the Length.

Set 22,19 upon E, to 24 upon D; then against 40 upon E, is 29,2, the Length required on D.

The Use of the Rule in Measuring Timber, Stone, Boards, &c.

P R O B. I.

The Diameter of a Circle given, to find the Circumference.

R U L E.

SET 1 upon A, to 3,14, &c. on B, (which Point is marked with C for Circumference,) and then against
any

any Diameter on A, you'll find its Circumference on B.

E X A M P L E.

Let the Diameter of a Circle be 40 Inches ; what's the Circumference ?

Set 1 on the Line A, to the Point c, on the Line B ; then against 40, on the Line A, you'll find 125,66 on the Line B, and such is the Circumference required.

P R O B. II

The Circumference given, to find the Diameter.

R U L E.

Set the Point c. 3,141, &c. on B, to 1 on A, then against any Circumference on B, you'll find its Diameter on A.

E X A M P L E.

Let the Circumference of a Circle be 125,66 Inches ; what's the Diameter ?

Set the Point c. upon the Line B, to 1 on the Line A ; then against 125,66 on the Line B, you'll find 40, the Diameter required on A.

P R O B. III.

The Diameter of a Circle given, to find the Side of a Square which shall be equal in Area thereto.

R U L E.

Set the Point (S e) i. e. 8862 on the Line B, to 1 on A ; then against the Diameter of any Circle on A, you'll find the Side of an equal Square on B.

G 2

E X-

E X A M P L E.

Let the Diameter of a Circle be 40 Inches; what's the Side of an equal Square?

Set S. e. (signifying Square equal,) *i. e.* ,8862 on B, to 1 on A; then against 40 on A, is 35,44 on B, and so much is the Side of a Square, whose Area will be equal to that Circle, of which 40 is the Diameter.

P R O B. IV.

The Diameter given, to find the Side of the greatest Square that can be drawn within the Circle to which that is a Diameter.

R U L E.

Set ,707106 mark'd with S. i. (signifying Square inscribed) on B, to 1 on A; then against any Diameter on A, you'll find the Side of the inscrib'd Square on B.

E X A M P L E.

Let the Diameter of a Circle be 40 Inches; what's the Side of the inscribed Square?

Set the Point Si = ,707, &c. on B, to 1 on A; then against 40 on A is 28,284, the Side of the Square required.

P R O B. V.

The Diameter of a Circle given, to find the Area thereof.

Set 1 upon D, to ,78539 (marked with O, d.) on C, then against any Diameter on D, you'll find the Area required on C.

E X A M.

E X A M P L E.

Let the Diameter of a Circle be 30 Inches ; what's the Area ?

Set 1 upon D, to ,78539 on C, then against 30 on D, you'll find 706,85 on C, for the Area required.

P R O B. VI.

The Circumference of a Circle given, to find the Area.

R U L E.

Set 1 upon D, to ,079578 (mark'd with $\odot$ c.) on C, then against any Circumference on D, you'll find the Area required on C.

E X A M P L E.

Let the Circumference of a Circle be 60 Inches ; what's the Area ?

Set 1 upon D, to ,079578 = $\odot$. c. on C, then against 60 on the Line D, is 286,48 on C, the Area required.

P R O B. VII.

The Breadth of a Board given in Inches, and the Length in Feet, to find the Content in Feet.

R U L E.

Set 12 on B, to the Breadth of the Board on A ; then against the Length of the Board on B, you'll find the Content on A.

E X A M P L E.

Let the Breadth of a Board be 20 Inches, and the Length 18 Foot ; what is the Content in Feet ?

G 3

Set

Set 12 on B, to 20 on A; then against 18 on B, is 30 on A, and that is the Area of the Board required.

P R O B. VIII.

The Length and Breadth of a Board given in Inches, to find the Content in Feet.

R U L E.

Set 144 on the Line B, to the Breadth of the Board on A; then against the Length on B, you'll find the Content on A.

E X A M P L E.

Let the Breadth of a Board be 20 Inches, and the Length 168; what's the Content in Feet?

Set 144 on B, to 20 on A; then against 168, on B, is 23,33 the Area required in Feet on A.

P R O B. IX.

The Breadth of a Board given in Inches, to find how much in Length thereof will go to make one Foot Square.

R U L E.

Set the Breadth given in Inches on B, to 1 on A; then against 144 on B, you'll find how much of the Board must be accounted one Foot Square?

E X A M P L E.

Let a Board be 16 Inches broad, how much in Length will go to make one Foot Square?

Set 16 upon B, to 1 on A; then against 144 on B, is 9 on

9 on A, and so much of that Board will go to make one Superficial Foot.

Of Timber or Stone.

P R O B. X.

Let a Piece of Square Timber or Stone be given to be measured, whose Length is 14 Foot, and Side 17 Inches ; what's the Content in Solid Feet ?

Set 12 upon D, to the Length; viz. 14 Foot on C; then against the Side of the Square, viz. 17 Inches on D, you'll find 28,097 on C, which is the Content required.

But if the Dimensions are given both in Foot Measure, then the Proportion is, As 1 upon D, is to the Length on C; so is the Side on D, to the Content on C.

P R O B. XI.

Let a Piece of Timber be given, whose Length is 22 Foot, Breadth 18 Inches, and Depth 13 ; what's the Content in Solid Feet ?

The common Way of measuring unequal-sided Timber, is to add the Breadth and Depth together, then half that Sum is taken for the Square of the Piece: But this is an Error too commonly used. However to proceed in our Business, you must find a mean Proportional betwixt the Depth and Breadth: thus set 18 on C, to 18 on D, then against 13 on C, you'll find 15,29 on D, and that is the Side of a square Piece of Timber; which being of the same Length with that given, will be equal to it; therefore set

12 on

12 on D, to 22 Foot, the Length of the Piece on C; then against 15,29 on D, you'll find 35,71 on the Line C; and so much is the Content of the Piece required.

P R O B. XII.

The Side of any Square Piece of Timber given in Inches, to find how many Inches in Length of the same Piece will go to make one Foot Solid.

R U L E.

Set the Side of the Square given on D to 1, on C; then against 41,5 on D, you'll find what's required on C.

E X A M P L E.

Let the Side be 15 Inches; how much in Length of the Piece will make one Foot Solid?

Set 15 on D, to 1 on C; then against 41,5 on D, is 7,68 on C; and so many Inches in Length will make one Foot Solid of that Piece.

Of Round Timber.

P R O B. XIII.

Let the Circumference of a Round Tree be 40 Inches, and the Length 16 Foot; what's the Content in Feet?

R U L E.

Always set 42,53 on D, to (the given Length in Feet, as in this Case) ,16 on C, then against the Circumference
on

on D, viz. 40, you'll find 14, 15 for the Content in Feet and Parts.

P R O B. XIV.

Let the Circumference of a Round Tree be 92 Inches; I would know how much thereof in Length would make one Foot Solid.

R U L E.

Set the Circumference, viz. 92 on D, to 12 upon C; then against 42, 53 (a fix'd Number for this purpose) on D, you'll find the Length of a Foot required upon C, viz. 2, 56. And the like may be done by any other Question of the like Nature. But such Persons as desire to see more of this, may peruse Mr. *Everard's Stereometry*, the Third or Fourth Edition.

And having thus given Directions to a Person who deals in Boards, Timber, or Stone; 'twill next be convenient to add something further about the Measuring of Wainscot, Plaistering, and Paving; which are generally agreed for by the Yard.

And therefore, when you have taken your Dimensions in Feet, and cast them up, divide the Sum by 9, so will you have the Content in Square Yards.

In taking the Dimensions (with a Line) you are to Girth over every Turn or Part of the Cornish, and all Parts of the Wainscot where the Mouldings swell much, from the Top of the Room to the Bottom, turning the Line over every such Part with the Thumb of your Right-Hand.

But you must Girth the Room without turning the Line upon the Mouldings, as you do in taking the Heighth.

Where observe, that in measuring Window-Shutters and Doors, you must allow Measure and half Measure; that is, whatever you measure a Door or a Shutter at, it must be accounted Half as much more.

E X.

E X A M P L E

The Heighth of a Room is 14 Foot 9 Inches, and Com-
pafs 146 Foot 6 Inches.

In which there are two Doors, each 6 Foot 3 Inches
Long, and 4 Foot Wide.

Also 4 Windows, each 2 Leaves for Shutters, which are
5 Foot 2 Inches High, and two Foot Broad.

What's the Content of such a Room in Square Yards ?

Compass of the Room is	146,5
Its Heighth	14,75
	7325
	10255
	5860
	1465

Content of the Room 2160,875 Square Feet.
Including Doors, Windows, and Chimney.

One Leaf of a Window-Shutter is 5.166 Feet Long
2. Wide.

Content of one in Square Feet is,	10,332
Number of Shutters or Leaves	8.

Content of all in Square Feet	82,656
-------------------------------	--------

Length

The General Gauger.

71

	<i>Foot.</i>
Length of one Door is	6,25
And Breadth	4.
Content in Square Feet	25,00
Number of Doors	2.
Their Content	50.
To which add the Shutters	82,656
Their Sum is	132,656
Half their Sum is	66,328
To this add the Room	2160,785
The Content is	2359,769

The Heighth of a Chimney is
Its Breadth is

$$\begin{array}{r}
 F. \text{ In.} \\
 4 : 6 = 4,5 \\
 3 : 3 = 3,25 \\
 \hline
 14,625 \\
 282,4155 \\
 \hline
 \end{array}$$

Content of the Chimney is
Which take from the Content above

$$\begin{array}{r}
 14,625 \\
 2359,769 \\
 \hline
 \end{array}$$

And there will remain the true Content of }
the Room

$$2345,144$$

Which divide by 9, will give Square Yards.

9) 2345,144 (260,571 Yards.
18

54

54

051

45

64

63

14

9

5

Painters take their Dimensions, and cast up, as Joyners do, but are not to account for Work and Half, but to account (in some Cases) the Room once, twice, or three Times done over, or so much *per* Yard, considering the Goodness of the Work; as white Painting is worth about 1 Shilling *per* Yard; Wall-nut-Tree Painting is worth 1 s. 4 d. or 1 s. 6 d. *per* Yard, and ordinary Branch Painting is worth 12 d. 14 d. or 16 d. *per* Yard, Japan Work, Plain, either Black or White, is worth 3 s. 6 d. or 4 s. *per* Yard, Gates and Out-doors are worth Painting 8 d. or 9 d. *per* Yard.

By the Sliding Rule.

Say, as 9 upon B, is to the Breadth upon A; so is the Length upon B, to the Content in Square Yards upon A.

E X-

E X A M P L E

Let the Length be 76,5 Feet, and Breadth 17,5 Feet ; what's the Content in Square Yards?

Set 9 upon B, to 17,5 upon A ; then against 76,5 on B, is 148,75 Square Yards upon A.

And the same Method serves either in Painting, Plastering, Joynery, or Paving.

But 'tis common among Plasterers to make no Allowance for Doors, Windows, or Chimnies.

For Flooring, Partitioning, Roofing, &c.

Partitioning, Flooring, Roofing, and Tying are measured by the Square of Ten, each Square being 100 Feet.

E X A M P L E. I.

Let the Length of a Floor be 76,2 Feet, and its Breadth 22,6 Feet, to find its Content in Squares.

$$\begin{array}{r} 100 : 76,2 : : 22,6 \\ 22,6 \end{array}$$

$$\begin{array}{r} 4572 \\ 1524 \\ 1524 \\ \hline \end{array}$$

Answer 17,2212 Squares.

By the Sliding Rule, set 100 on B, to 76,2 on A ; then against 22,6 on B, you'll find 17,22 on A.

E X A M P L E II.

Let the Length of a Building be 125 Feet, and Breadth

H

49 ;

49 ; I demand how many Squares of Roofing or Tyling it contains.

As 100 the Square Feet in a Square, is to 75,5, (twice the Length of the Rafter in Feet,) so is the Length 125, to 94,375 the Content in Squares, (*i. e.*)

$$100 : 75,5 :: 125.$$

$$\begin{array}{r} 3775 \\ 1510 \\ 755 \\ \hline 94,375 \end{array}$$

By the Sliding Rule, set 100 on B, to 125 on A ; then against 75,5 on B, is 94,37 on A, as above.

Here observe, That the Breadth of the Floor, is to the Length of the Rafter, as 4 to 3, to which you must add the Vallies and Eves.

To Measure Brick Work.

Brick Work is cast up by the Rod Square, each containing 272,25 Square Feet.

Where you must remember, that all Brick Work must be reduced to the Standard Measure of one Brick and Half thick, which may most easily be done by the Help of the following Table ; which goes as far as any Brick Wall is in Thickness at this Time.

EXAMPLE I.

Let the Height of a Wall be 22,5 Feet, and Length 156,25 ; I demand the Content in Square Rods at 1 Brick and $\frac{1}{2}$ Thick.

Look

The General Gauger.

75

Look in the Table for the given Thickness, viz. 1,5, and against it you'll find 272,25; then say

$$272,25 : 156,25 :: 22,5$$

$$\begin{array}{r} 22,5 \\ \hline \end{array}$$

$$78125$$

$$31250$$

$$31250$$

$$272,25) \quad 3515,6250 \quad (12,51 \text{ Answer}$$

$$793120 \begin{array}{l} 5 \\ 7 \end{array}$$

$$24860 \begin{array}{l} 7 \\ 8 \end{array}$$

$$036 \begin{array}{l} 7 \\ 8 \end{array}$$

$$(8$$

E X A M P L E II.

Let the Height of a Wall be 2 Bricks 'Thick, 243 Feet Long, and 16,2 Feet High; what's the Content in Square Rods?

Look in the Table for 2,0, and against it you'll find

$$204,19 : \text{Then say}$$

$$204,19 : 243, : : 16,2$$

$$16,2$$

$$\begin{array}{r} 486 \\ \hline \end{array}$$

$$1458$$

$$243$$

$$204,19) \quad 3936,6000 \quad (19,27 \text{ Answer.}$$

$$20419$$

$$189470$$

$$183771$$

$$56990$$

$$40838$$

$$161520$$

$$142933$$

$$18547$$

H 2

Suppose

Suppose this Wall to have a Water Table 3 Bricks Thick, and 4 Foot High; what's the Content of the whole Wall? Against 3 in the Table, you'll find 136,12; then say

$$\begin{array}{r}
 136,12 : 243, : : 4 \\
 \hline
 4 \\
 136,12 \quad 972,0000 \quad (7,14 \\
 \quad \quad 95284 \\
 \hline
 \quad \quad 19160 \\
 \quad \quad 13612 \\
 \hline
 \quad \quad 55480 \\
 \quad \quad 54448 \\
 \hline
 \quad \quad 1032
 \end{array}$$

The upper Part of the Walls is	19,27	Square Rods.
The Water Table is	7,14	Square Rods.
The whole Content of the Wall	26,41	Square Rods.

When you measure Brick Work, you must find the Content of each Wall severally, and from it subtract all the Doors and Windows.

By the Sliding Rule.

Set 272,25 on B, to the Length of a Wall (of any Thickness) on A; then against the Breadth on B, you'll find the Content in Square Rods on A; if the Wall be just 1 $\frac{1}{2}$ Brick Thick, but if more or less, 'twill require a second Operation, thus: Set 3 on B, to the Number of half Bricks the Wall is thick on A; then against the Content or fourth Number found by the first Operation, on B, you'll

you'll find the true Content of the Wall, &c. on A : Or, set the tabular Number found against the Thickness on B, to the Length of a Wall on A ; then against the Breadth on B, you'll find the Content on A, at once.

Bricks Thick.	Square Feet in a Rod.
0,5	816,75
1,0	403,37
1,5	272,25
2,0	204,19
2,5	163,35
3,0	136,12
3,5	116,67
4,0	102,09
4,5	90,75
5,	81,68
5,5	74,25
6,	68,06
6,5	62,82
7,	58,34
7,5	54,45
8,	41,04
8,5	48,04
9,	45,37
9,5	42,98
1,0	40,83

Note, That about a Thousand of Bricks, will do a Rod of Work on a two Brick Wall.

The laying of which Number, will be about a Days Work for a Bricklayer and a Labourer.

Glaſiers measure their Work by the Foot Square, and is the same with that of measuring Boards ; the Dimensions of either may be taken in Feet and Inches, and the Content found by cross Multiplication.

EXAMPLE.

Let the Breadth of a Pane of Glas be
And its Length

F. In.

$$\begin{array}{r} 4 : 3 \\ 6 : 6 \end{array}$$

$$\begin{array}{r} 24 : \\ 1 : 6 \\ 2 : 0 \\ 0 : 1 : 6 \end{array}$$

Content in Square Feet, Inches, and Parts. $27 : 7 : 6$

Which is done thus.

1. First multiply 4 Foot by 6 Foot, and the Product is 24 Foot, which set under F.

2. Then 3 Inches by 6 Foot gives 18 Inches, or 1 Foot 6 Inches; which set down under the former, as you see.

3. Multiply 4 Foot by 6 Inches, the Product is 24 Inches, or 2 Foot.

4. Multiply 3 Inches by 6 Inches, and the Product is 18 Parts; which divide by 12, and the Quotient is 1 Inch, and 6 Parts remains, which set down.

Lastly, Add all into one Sum, and you'll have the Answer, viz. 27 Foot, 7 Inches, and 6 Parts.

And after the same Manner, you may cast up any Thing else, whose Dimensions are given in Feet and Inches, &c.

In many Cases, 'twill be necessary to take your Dimensions in Feet, Inches, and Parts, i. e. to Halves and Quarters, (as in Glazing, &c.) in which for a Quarter of an Inch, set down 3 Parts.

For half an Inch, you must set down 6 Parts.

And for three Quarters of an Inch, 9 Parts, (supposing

12 Parts make an Inch as 12 Inches does a Foot,) here note, That

Feet multiplied by Feet, give Feet.

Feet by Inches, give Inches.

Feet by Parts, give Parts.

Inches by Inches, give Parts.

Inches by Parts, give Seconds.

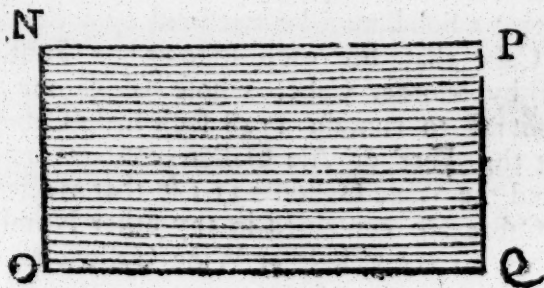
Parts by Parts, give Thirds.

Gauging performed Arithmetically and Instrumentally.

WHEN the young Gauger has stored his Memory with the foregoing Notions, he may venture upon this Part; but first ought to know something of the *Genesis* of Quantity, *i. e.* That a Point begets a Line, as the Point A, moved from B to C, will leave the Trace, or describe the Line BC.

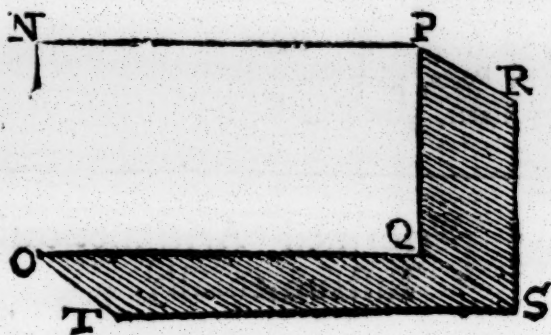
A (.) B ————— C.

And a Line begets a Surface, if we conceive it to be mov'd through any Space, parallel to its self, as we conceive the Line BC to be moved parallel to it self, between the Lines NO and PQ, it will by that Motion, describe the Surface NOPQ.



Lastly,

Lastly, If we imagine this Surface to sink Perpendicularly and Parallel to its self, it will, by such a Motion, describe a Solid, as NOPQRST.



1. A Point is said to be that which has no Parts.
2. A Line is that which has Length, but not Breadth.
3. A Surface is that which has both Length and Breadth.
4. A Solid admits of Length, Breadth and Thickness.

Having a clear Apprehension of what has been said, we are to learn, that a Line is measured by a Line; as a Line 3 Foot long, may be measured by a Line that is one Inch long, and be found to contain 24 such.

And that a Superficies, must be measured by a Superficies: So a Superficies that is one Foot Square, may be measured by another Superficies, that is but one Inch Square, and found to contain 144 such little Squares.

Also, that a Solid must be measured by a Solid.

So a Cube that has each Side = one Foot, may be measured by another Cube, whose Side is one Inch, and will be found to contain 1728 such little Cubes. *Where note*, that the Beer or Ale Gallon contains 282 cubical Inches, and the Wine Gallon 231; so that as often as either of these Cubes are contained in any other Number of cubical Inches, so many Beer or Wine Gallons are contained therein.

Where

Where note also, That it was Enacted in the Act of laying a Duty upon Malt, that every round Bushel with a plain and even Bottom, being 18,5 Inches Diameter (from Top to Bottom) and 8 Inches Deep, shall be esteemed a legal *Winchester* Bushel, according to the Standard in her Majesty's *Exchequer*. Now, if we would find a Divisor for a Malt Bushel, it must be done by finding the solid Content of that Cylinder, whose Diameter is 18,5 Inches, and Depth 8; and that will be 2150,419, &c. And this is the Divisor for all right-lined Figures: And if the Proportion between this and the circular Divisor is, as 1,570796 to 2, (as it is) the circular Divisor will be 2737,999. But Mr. *Everard* says, that 2150, and 2737,47 is sufficient in Practice.

To Gauge a Square.

DEFINITION.

A Square has all its Sides equal, and its Angles right.

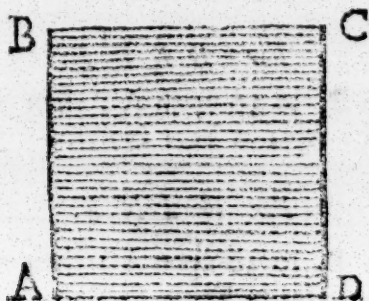
RULE.

Square the Side, and divide the Square by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt.

EXAMPLE.

Let the Side BC of the Square ABCD be 30 Inches: I demand the Area in Beer, Wine, and Malt.

FIGURE.



For

*The General Gauger.**For B E E R.*

Side = 30

282)	30	
	900,000	(3,191 Area in Beer Gal-
	054828	lons at one Inch Deep.
	2543	
	01	

For W I N E.

231)	900,000	(3,896 Area at one Inch
	207214	Deep in Wine Gallons.
	2242	
	10	

For MALT BUSHEL S.

2150)	900,0000	(,4186 Area in Malt.
	0400000	
	18500	
	131	
	0	

*By the Sliding Rule.**For B E E R.*

Set 282 upon B, to 30 upon A ; then against 30 on B, is 3,19 on A, the Area in Beer Gallons required.

For W I N E.

Set 231 upon B, to 30 upon A ; then against 30 on B, is 3,89 on A, the Area in Wine Gallons required.

For

For M A L T.

Set 2150 upon B, to 30 on A; then against 30 on B, is 4186 on A, the Area in Malt. Here you are to know, that this may be called the Rule of Three by the Lines. For as 282, is to 30, so is 30 to 3,191, *i. e.* in that Rule you must set the first Number in the Proportion on B, to the second on A; then against the third on B, you'll find the fourth required on A, &c.

To Gauge a Parallelogram.

D E F I N I T I O N.

A Parallelogram is a four-sided Figure, whose two opposite Sides (ab, cd or ac, bd) are parallel Lines.

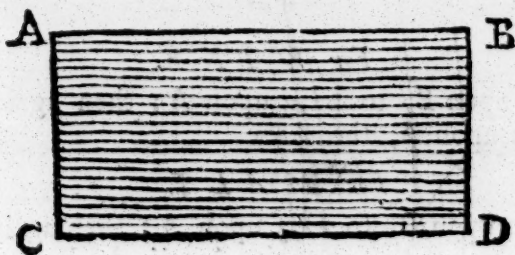
R U L E.

Multiply the Length by the Breadth; then divide the Product by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt Bushels.

E X A M P L E.

Let ABCD be a Parallelogram, whose Length AB or CD is 40 Inches, and its Breadth AC or BD 22,3; what's the Area in Beer, Wine, and Malt?

F I G U R E.



For

*The General Gauger.**For B E E R.*

Breadth 22,3

Length 40

282) 892,0000 (3,1631, the Area required.
 0468848
 17835
 000

For W I N E.

231) 892,0000 (3,8614 Area.
 199249(6
 1430(6
 1(1

For M A L T.

2150) 892,0000 (,4148 Area.
 32000(0
 1050(0
 12(8
 -(1

*By the Sliding Rule.**For B E E R.*

Set 282 upon B, to 22,3 upon A; then against 40 upon B, is 3,163 upon A; which is the Area required.

For W I N E.

Set 231 upon B, to 22,3 upon A; then against 40 on B, is 3,861 upon A, the Area.

For M A L T.

Set 2150 upon B, to 22,3 upon A; then against 40 on B, you'll have ,4148 on A, the Area in Malt.

To

To Gauge a Rhombus.

DEFINITION.

A Rhombus has equal Sides, but unequal Angles:

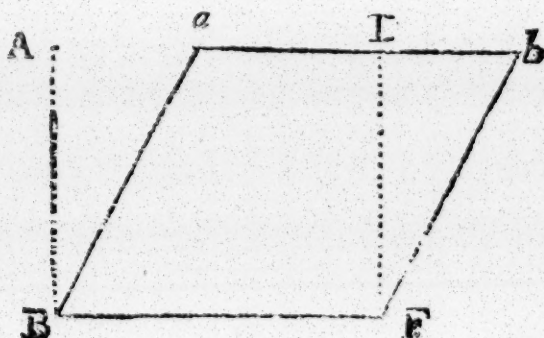
RULE.

It is demonstrated by the 35th Proposition of the first Book of *Euclid*, that Parallelograms having the same Base, and being between the same Parallels are equal, *i. e.* that the Parallelogram $ABDF$ is equal to the Rhombus $abBF$; therefore, if you multiply BF by BA or DF , the Product will be the Area in Inches; which divide by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt Bushels.

EXAMPLE.

Let $abBF$ be a Rhombus, whose Side BF is 40 Inches; ($=AD=ab=bF$;) and let the nearest Distance of any two opposite Sides *e. g.* ab and BF , *i. e.* $DF=AB$ be 34 Inches; I demand the Area in Beer, Wine, and Malt.

FIGURE.



The General Gauger.

For B E E R.

BF=40

DF=34

Gall.

282) 1360,000 (4,822 Area.

232466

9679

01

For W I N E.

231) 1360,000 (5,887 Area.

205223

2070

11

For M A L T.

2150) 1360,0000 (6,325 Area.

0700000

05505

122

1

By the Sliding Rule.

For B E E R.

Set 282 upon B, to 40 on A; then against 34 on B, is 4,822 on A; the Area as above.

For W I N E.

Set 231 on B, to 40 on A; then against 34 on B, is 5,887 on A; the Area as above.

For M A L T.

Set 2150 upon B, to 40 on A; then against 34 on B, is 6,325 on A; the Area as above.

To

To Gauge a Triangle.

DEFINITION.

Triangles have various Species, first in Relation to their Sides, one is called Equilateral, or equal-sided.

Another Equicrural having two Sides equal: And a third Scalenum, because all its Sides are unequal; and in general, a Triangle is a Figure bounded with three right Lines.

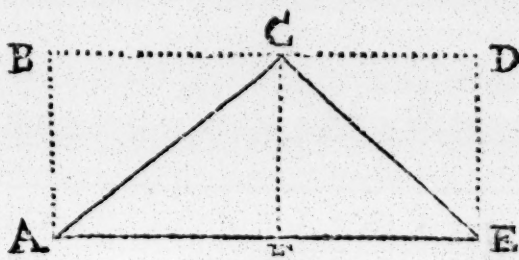
RULE.

Euclid in the 41st of his first Book proves, that a Parallelogram will be double to a Triangle, if they be between the same Parallels, and have equal Bases; as the Triangle ACE is but Half the Parallelogram BDEA, for the Triangle ACF is but Half the Parallelogram BCAF, and the Triangle FCE is Half the Parallelogram FCDE; therefore $ACE = \text{Half } BDEA$. Q. E. D.

Therefore multiply the Base AE by half the Perpendicular FC, and the Product is the Area in Inches; which divide by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt.

EXAMPLE.

Let ACE be a Triangle, whose Base AE is 60 Inches, and Perpendicular $FC = 36$; what's the Area in Beer, Wine, and Malt?



*The General Gauger.**For B E E R.*

AE the Base=60
 half the Perp. FC=18

182) 1080,000 (3,829 Area.
 234462
 0872
 22

For W I N E.

231) 1080,000 (4,675 Area.
 156435
 1727
 10

For M A L T.

2150) 1080,0000 (5,023 Area.
 2050000
 5005
 075
 0

*By the Sliding Rule.**For B E E R.*

Set 182 upon B, to 60 on A; then against 18 on B, is 3,829 on A, the Area as above.

For W I N E.

Set 231 on B, to 60 on A; then against 18 on B, is 4,675 on A, the Area as above.

For M A L T.

Set 2150 upon B, to 60 on A; then against 18 on B, is 5,023 on A, the Area as above.

To

To Gauge a Trapezium.

DEFINITION.

A Trapezium is a Figure consisting of four unequal Sides, as ABCD.

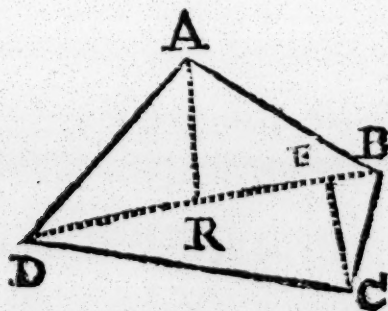
RULE.

Having divided the Trapezium into Triangles, as in the Figure following, add the two Perpendiculars, *viz.* AR and FC together, and multiply that Sum by Half the Base BD, and the Rectangle or Product is the Area in Inches; which divide by 282 for Beer Gallons; 231 for Wine, and 2150 for Malt Bushels.

EXAMPLE.

Let ABCD be a Trapezium, let the common Base DB be 102 Inches, the Perpendicular AR 40, and FC=30; I demand the Area in Beer, Wine, and Malt.

FIGURE.



*The General Gauger.**For B E E R.*

$AR=40$

$FC=30$

$Sum=70$

$\frac{1}{2} DB=51$

$$\begin{array}{r}
 282) \quad 3570,000 \quad (12,659 \text{ Area.} \\
 \underline{0756802} \\
 18676 \\
 \underline{121}
 \end{array}$$

For W I N E.

$$\begin{array}{r}
 231) \quad 3570,000 \quad (15,454 \text{ Area.} \\
 \underline{1265656} \\
 10202 \\
 \underline{111}
 \end{array}$$

For M A L T.

$$\begin{array}{r}
 2150) \quad 3570,000 \quad (1,660 \text{ Area.} \\
 \underline{1420000} \\
 13000 \\
 \underline{010} \\
 1
 \end{array}$$

*By the Sliding Rule.**For B E E R.*

Set 282 on B, to 70 upon A; then against 51 on B, is 12,659 on A; the Area required.

For W I N E.

Set 231 on B, to 70 upon A; then against 51 on B, is 15,454 on A; the Area required.

For

For MALT.

Set 2150 upon B, to 70 on A; then against 51 on B, is 1,660 upon A; the Area as above.

To Gauge a Hexagon.

DEFINITION.

A Hexigon is a Polygon of six equal Sides, and as many Angles; as ABCDEF.

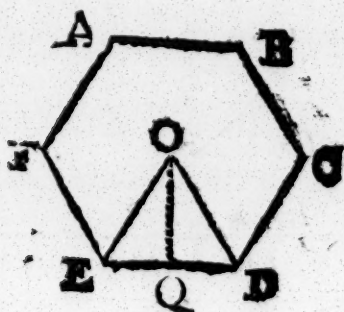
RULE.

All Polygons may be measured by one general Rule, viz. Multiply the Sum of all their Sides, by Half the Distance of any Side from the Center, and divide the Product by 182 for Beer Gallons, 231 for Wine, and 2150 for Malt.

EXAMPLE.

Let ABCDEF be a Hexagon; any of whose Sides is 12 Inches, and the nearest Distance from the Center to the Middle of any Side, as OQ is 11,4 Inches; what's the Area in Beer, Wine, and Malt?

FIGURE.



For

*The General Ganger.**For B E E R.*

12
6
—

Sum of the Sides = 72

Half the Perpendicular 5,7

504
360
—

282) 410,400 1,455 Area.
128600
1559
10

For W I N E.

231) 410,400 (1,776 Area.
179734
1754
11

For M A L T.

2150.) 410,4000 (1,908 Area.
954000
01900
198
1

*By the Sliding Rule.**For B E E R.*

Set 282 upon B, to 72 on A; then against 5,7 on B, is
1,455 on A; the Area as above.

For

For WINE.

Set 231 upon B, to 72 on A; then against 5,7 on B, is 1,776 on A; the Area as above.

For MALT.

Set 2150 upon B, to 72 on A; then against 5,7 on B, is 1,908 on A; the Area as above.

To Gauge a Circle.

DEFINITION.

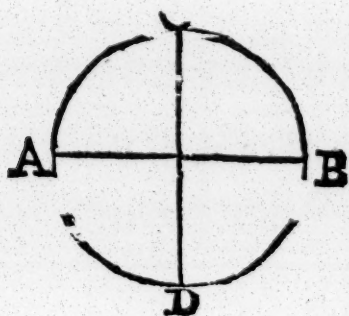
A Circle is a plain Figure, terminated by the encompassing of one Line, which is called the Circumference, and is every where equally remote from the middle Point or Center.

RULE.

Divide the Square of the Diameter of any Circle by 359 for Beer Gallons, 294 for Wine, and 273,47 for Malt.

EXAMPLE.

Let ABCD be a Circle, whose Diameter AB is 40 Inches; what's the Area in Beer, Wine, and Malt?



For

*The General Gauger.**For B E E R.*

The Diameter = 40 Inches.

$$\begin{array}{r}
 40 \\
 \hline
 359) \quad 1600,000 \quad (4.456 \text{ Area.} \\
 \quad 164456 \\
 \quad \quad 2049 \\
 \quad \quad \quad 22
 \end{array}$$

For W I N E.

$$\begin{array}{r}
 294) \quad 1600,0000 \quad (5.4421 \text{ Area.} \\
 \quad 1304426 \\
 \quad \quad 12652 \\
 \quad \quad \quad .002
 \end{array}$$

For M A L T.

$$\begin{array}{r}
 2737.47) \quad 1600,00000 \quad (.584 \text{ Area.} \\
 \quad 23126542 \\
 \quad \quad 122675 \\
 \quad \quad \quad 1317
 \end{array}$$

*By the Sliding Rule.**For B E E R.*

Set 359 upon B, to 40 on A; then against 40 on B, is 4.456 on A, the Area as above.

For W I N E.

Set 294 upon B, to 40 on A; then against 40 on B, is 5.4421 on A, the Area as above.

For M A L T.

Set 2737.47 upon B, to 40 on A; then against 40 on B, is .584 on A, the Area as above.

To

To Gauge a Sector of a Circle.

DEFINITION.

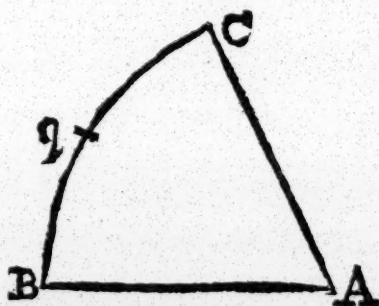
A Sector of a Circle is contained upon the Ends of two right Lines or Semi diameters, making an Angle in the Center, having any Part of the Circumference for its Base.

RULE.

Multiply the *Radius* or Semi-diameter AB or AC by Half the Arch of the Section BC. *i. e.* Cq and divide the Product by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt.

EXAMPLE.

Let AB q C be a Sector of a Circle, and let the *Radius* AB=AC be 40 Inches, and BC=20, then is Bq=Cq=10; I demand the Area in Beer, Wine, and Malt.



For B E E R.

Radius AB or AC=40
Half the Arch Line BC=10

$$\begin{array}{r}
 282 \overline{) 400,000} \quad (1,418 \text{ Area.} \\
 \underline{118284} \\
 0532 \\
 \underline{21}
 \end{array}$$

For

*The General Gauger.**For WINE.*

231) 400,000 (1,731 Area.
 169379
 733
 (1

For MALT.

2150) 400,0000 (1,860 Area.
 1850000
 13000
 10
 10

*By the Sliding Rule.**For BEER.*

Set 282 upon B, to 40 on A; then against 10 on B, is 1,418 on A; the Area as above.

For WINE.

Set 231 upon B, to 40 on A; then against 10 on B, is 1,731 on A, the Area as above.

For MALT.

Set 2150 upon B, to 40 on A; then against 10 on B, is 1,860 on A; the Area as above.

*To Gauge an Oval.**DEFINITION.*

An Oval or Ellipsis is a circular Figure, as ABCD, having two unequal Diameters, as AB, which is called the Transverse, and CD the conjugate Diameter, and proved by

The General Ganger.

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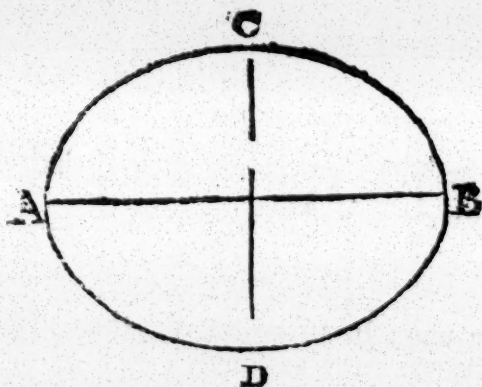
by *Archimedes* to be a mean Proportional between the two Circles that may be described severally on these Diameters.

R U L E.

Multiply the transverse Diameter AB, by the conjugate Diameter CD; then divide the Product by 359 for Beer Gallons, 294 for Wine, and 2737.47 for Malt Bushels.

E X A M P L E.

Let the Figure ABCD be an Oval or Ellipsis, whose conjugate Diameter CD let be 40 Inches, and transverse Diameter AB 50; what's the Area thereof in Beer, Wine, and Malt?



For B E E R.

$$AB=50$$

$$CD=40$$

$$\begin{array}{r} 359 \overline{) 2000,000} \\ \underline{205571} \\ 253100 \end{array} \quad (5,571 \text{ Area.}$$

K

For

*The General Gauger.**For WINE.*

294) 2000,000 (6,802 Area.
 236802
 0081
 02

For MALT.

2737,47 (2000,0000 (.73 Area.

*By the Sliding Rule.**For BEE R.*

Set 359 upon B, to 50 on A; then against 40 on B, is 5,571, the Area as above.

For WINE.

Set 294 upon B, to 50 on A; then against 40 on B, is 6,802 on A, the Area as above.

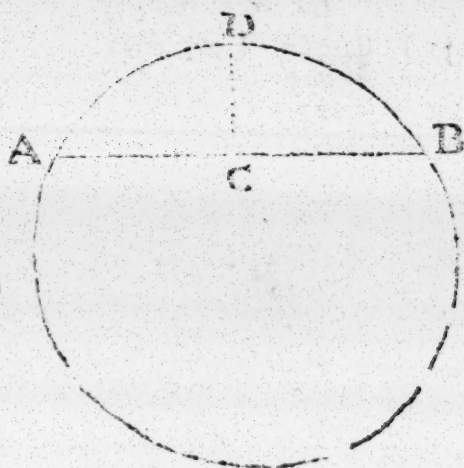
For MALT.

Set 2737,47 upon B, to 50 on A; then against 40 on B, is, 73 on A, the Area as above.

To Gauge the Segment of a Circle.**DEFINITION.**

A Segment of a Circle is a Figure contained between a right Line AB (called a Chord) and any Part of a Circumference called an Arch, as ADB.

RULE.



R U L E.

Multiply the Chord AB by two Thirds of the versed Sine DC, and the Product will be very near the Area in Square Inches; which divide by 282 for Beer Gallons, 231 for Wine Gallons, and 2150 for Malt Bushels.

E X A M P L E.

ABD in the preceding Figure is a Segment of a Circle, whose Chord Line AB is 22,2 and versed Sine DC is 5,7 Inches; what's the Area thereof in Beer, Wine, and Malt?

For B E E R.

$$\begin{array}{r}
 \text{DC} = 5,7 \\
 \text{Two Thirds is} \quad 3,8 \\
 \text{AB} \quad \quad \quad 22,2 \\
 \hline
 1776 \\
 666 \\
 \hline
 282 \overline{) 84,360} \quad (299 \text{ Areas} \\
 \underline{2798(2} \\
 25(4 \\
 (0 \\
 \text{K 2}
 \end{array}$$

For

*The General Gauger.**For W I N E.*

231,) 84,360 (.365 Area.
 15005
 124
 0

For M A L T.

2150) 84,3600 (.0392 Area.
 19860(0
 051(0
 (8

By the Sliding Rule.

First to find $\frac{2}{3}$ of $DC=5,7$: Set 3 the Denominator on B, to 2 the Numerator on A; then against the versed Sine 5,7 on B, you'll find 3,8 on A, which is $\frac{2}{3}$ of 5,7 as above.

For B E E R.

Set 282 upon B, to 3,8 upon A; then against 22,2 upon B, you'll find, 299, the Area as above.

For W I N E.

Set 231 upon B, to 3,8 upon A; then against 22,2 on B, you'll find ,365 on A, the Area as above.

For M A L T.

Set 2150 upon B, to 3,8 on A; then against 22,2 on B, you'll find ,0392 on A, the Area as above.

To find the Area of an irregular Superficial Figure.

Divide it into Triangles, Trapeziums, &c. as the Nature

ture of the Figure, will bear; then find the Contents of those several Parts in Inches, and add them together; which Sum divide by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt Bushels.

E X A M P L E.

Let ABCDEGF be an irregular Figure, whose Area in Beer and Wine Gallons is required; this Figure, when divided, as you see, is two Trapeziums, and one Triangle, whose Dimensions you may also see in the same Figure.

Find their Areas, as you did those of the Trapezium and Triangle, (at pag. 90 and 88,) which will be

	<i>Inches.</i>
Area of the Trapezium FABC is	560
Area of the Trapezium FCDE is	480
Area of the Triangle FEG is	170
Their Sum is	1210

For B E E R.

$$\begin{array}{r} 282 \overline{) 1210,00(0} \quad (4,29 \text{ Area.} \\ \underline{0826} 2 \\ 25 2 \\ \underline{ 0} \end{array}$$

For W I N E.

$$\begin{array}{r} 231 \overline{) 1210,000} \quad (5,238 \text{ Area.} \\ \underline{0558} 7 2 \\ \underline{ 088} 2 \\ 0 \end{array}$$

*The General Gauger.**For MALT.*

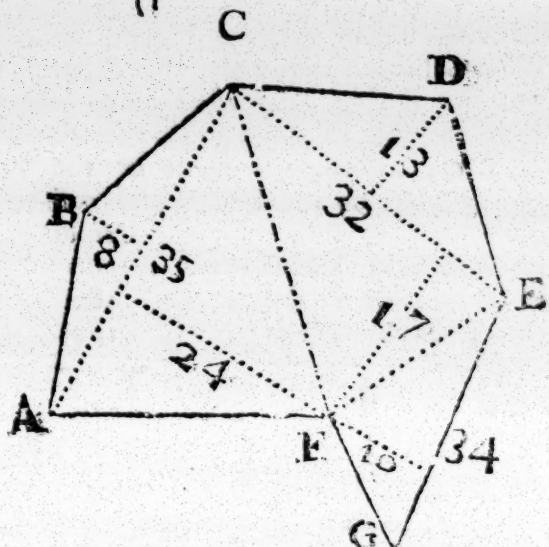
2150,) 1210.0000 (,5627 Area in Malt Bushels.

135000(0

0600(5

17(9

(1

*EXAMPLE II.*

Let ABCDEFGHIKLMNP be an irregular Figure, which being divided into convenient Parts, will appear as you see, and the Content of each Part be as follows.

The Area of the Triangle, EPM is	63
The Area of the Trapezium, EPAD is	260
The Area of the Trapezium, ABCD is	154
The Area of the Trapezium, EFGK is	442
The Area of the Segment, HIKQ is	40
The Area of the Trapezium, KLME is	169

Their Sum is	1128
The Area of the Segment, MNPO is	24

The Remainder is 1104 which is the

NOTES upon the foregoing Examples.

1st, That if the Sides of any Tun are parallel, and that it has any of the preceding Figures for its Base; the Content of all such Tuns may be found by multiplying the Area of their Bases (found as above directed) by the Depth, and this Will always hold; let the Area of the Base be found in what Denomination soever, i. e. whether in Feet, Inches, Ale, Wine, or Malt, &c.

2^{dly}, That when you are to divide by 282 for Beer Gallons, and 231 for Wine, you may multiply the intended Dividend by .0035461, and the Product will be the Content in Beer Gallons, and by .004329, and the Product will be the Content in Wine Gallons.

3^{dly}, That when you are to divide by 359 for Beer Gallons, and 294 for Wine, (as in Circles, &c.) you may multiply the intended Dividend by .0027855, and the Product will be the Content in Beer Gallons, and by .0034, and the Product will be the Content in Wine Gallons.

4^{thly}, That when you are to divide by 2737.47, the Divisor for a Circle in Malt Bushels,

Or by 2150 the Divisor for Squares, &c. you may multiply the Square of the Diameter of a Circle, or any other proper Dividend to the Divisor, by .0003653. And the Square of the Side of a Square, &c. by .0004651, so will the Products be the same as the Quotients would have been, if the Division had been made.

The Reasons why the Multipliers before mentioned will perform the same as the Divisors, may be deduced from *Prop. 33. Lib. 1. Almagest. Enucleata*, where 'tis demonstrated, that similar plane Figures are to one another in duplicate Proportion of their homologous Sides; and also from *Euclid, Prop. 2. Lib. 12.* where 'tis demonstrated,

monstrated, that Circles are in the same Proportion as the Squares of their Diameters.

Now since Squares are to one another, as the Squares of their Sides; let us suppose the Side of a Square to be 1 Inch, then by the preceding Rule for that Purpose, the Area of such a Square in Beer Gallons will be ,0035461, and in Wine, ,004329; therefore as the Square of 1, *i. e.* but 1, is to its Area, *viz.* ,0035461 in Beer, or ,004329 in Wine, so is the Square of the Side of any other Square, to the Area thereof in Beer or Wine. Now according to the Rule of Proportion, we ought to multiply the second and third Numbers together, and divide the Product by the first, but because in this Case the first Number is but 1, the Product must be the Answer; for 1 will neither multiply nor divide.

The same is to be said of Circles; since (as above) they are to one another in the same Proportion as the Squares of their Diameters: if we suppose the Diameter of a Circle to be 1, then by the preceding Rule for that purpose, the Area in Beer will be ,0027855, and in Wine ,0034. Therefore, as the Square of the Diameter, *viz.* 1, *i. e.* but 1, is to its Area, ,0027855 in Beer, or to ,0034 in Wine, so is the Square of any other Diameter to the Area of its Circle; and herealso, because 1 is the first Number of the Proportion, and can't divide, the Product must be the Answer; and the same Reason serves for the Malt Multipliers.

To Gauge a Cube.

DEFINITION.

A Cube (or Dye) is a solid Figure contained under 6 equal Squares.

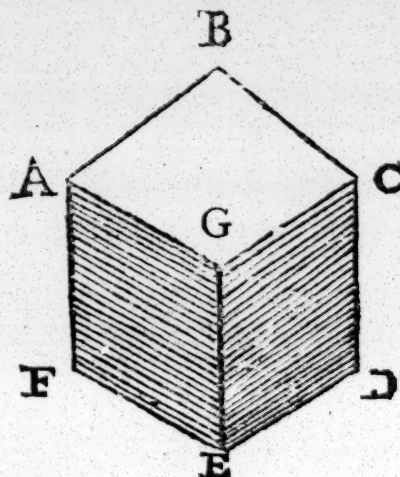
RULE.

Cube the Side, (*i. e.* multiply the Side of the Cube by it self, and that Product again by the Side of the Cube.)
then

then divide that cubed Number by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt.

E X A M P L E.

Let ABCDEFG represent a Cube, whose Side let be 20 Inches; I demand the Content in Beer and Wine Gallons.



Side=20
20

400 its Square.

20
282) 8000,00 (28,36 Beer.
236443
1094
12

For WINE.

231) 8000,00 (34,63 Content in Wine.
107647
1474
00

For

The General Gauger.

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For M A L T.

2150,) 8000,00 (3,720 Content in Malt.

By the Sliding Rule.

To perform this Question by the Instrument at one Operation, there ought to be inserted in the Line D, three Gauge Points, *i. e.* one at 16,79, the Square Root of 282 for Beer Gallons; one at 15,19, the Square Root of 231 for Wine, and one at 46,36, the Square Root of 2150 for Malt Bushels; and their Use is as below.

For B E E R.

Set 16,79 upon D, to 20 on C; then against 20 on D, is 28,36, the Content in Beer as above.

For W I N E.

Set 15,19 upon D, to 20 on C; then against 20 on D, is 34,63 on C, the Content in Wine as above.

For M A L T.

Set 46,36 upon D, to 20 on C; then against 20 on D, is 3,720 on C, the Content required.

To Gauge a Parallelopipedon.

D E F I N I T I O N.

A Parallelopipedon is a solid Figure contained under six Parallelograms, the opposite of which are parallel.

R U L E.

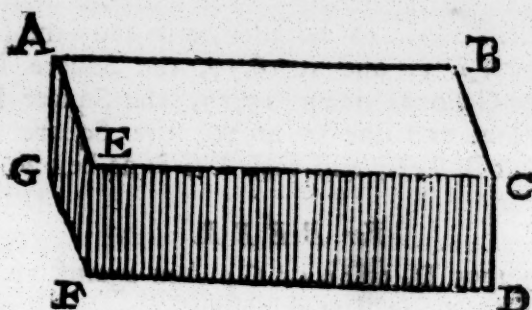
Multiply the Length by the Breadth, and the Product by the Depth; then divide by 282 for Beer Gallons, 231 for Wine, and 2150 for Malt Bushels.

E X-

The General Gauger.

E X A M P L E.

Let ABCDEFG represent a Parallelopipedon, whose Length AB is 40 Inches, the Breadth BC=20 Inches, and Depth CD=15; what's the Content in Beer, Wine, and Malt?

*For B E E R.*

Length 40

Breadth 20

800

Depth 15

282)	12000,00	(42,55 Beer Gallons.
	072600	
	1559	
	10	

For W I N E.

231)	12000,00	(51,94 Content in Wine.
	045916	
	2118	
	11	

For M A L T.

2150,)	120001,000	(5,581 in Malt Bushels.
--------	------------	-------------------------

By

By the Sliding Rule.

First, by *Prob. 1.* of the Use of the Square Root by the Lines C and D, (in the preceding Part) find a mean Proportional between the Length $AB = 40$, and the Breadth $BC = 20$; which, according to the Rule there given, you'll find to be 28,28 Inches. Then

For B E E R.

Set the Gauge Point 16,79 on D, to 15 the Depth on C; then against 28,28 (the Mean) on D, you'll find 42,55 on C, the Content as above.

For W I N E.

Set the Gauge Point 15,19 on D, to 15 the Depth on C; then against 28,28 (the Mean) on D, you'll find 51,94, the Content on C.

For M A L T.

Set the Gauge Point 46,36 on D, to 15 on C; then against 28,28 on D, is 5,581 on C; the Content required.

To gauge a Prism.

D E F I N I T I O N.

A Prism is a Solid Figure, the two opposite Ends of which are equal alike and parallel; and all other Sides are Parallelograms.

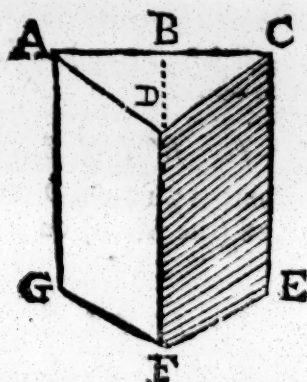
R U L E.

Multiply the Base of the Triangle at the End by Half the Perpendicular, then multiply that Product by the
L Depth,

Depth, and divide the last Product by 282 for Beer, 231 for Wine, and 2150 for Malt.

E X A M P L E.

Let *ABCDEFG* represent a Triangular Prism, (for there are diverse Sorts of them, but all take their Denomination from their Bases or Ends) let *AC* be 40 Inches, *BD* = 22 Inches, and the Depth *AG* = 60; what's the Content in Beer and Wine Gallons, and Malt Bushels?



For B E E R.

$$\begin{array}{r} AC = 40 \\ \text{Half } BD = 11 \\ \hline \end{array}$$

$$\begin{array}{r} 440 \\ \text{Depth } 60 \\ \hline \end{array}$$

$$\begin{array}{r} 282 \quad 26400,00 \quad (93,61 \text{ Content in Beer} \\ \quad 102488 \quad \text{Gallons.} \\ \quad 1749 \\ \quad 01 \end{array}$$

For

The General Gauger.

LII

For W I N E.

231) 26400,00 (114,28 Content in Wine
0339682 Gallons.
09693
011

For M A L T.

215,0) 26400,00 (12,27 Content in Malt.

By the Sliding Rule.

First find a mean Proportional between Half BD = 11, and AC=40; which by the Sliding Rule is 20,97. Then

For B E E R.

Set the Gauge Point 16,79 on D, to 60 on C; then against 20,97 on D, is 93,61 on C, the Content as above.

For W I N E.

Set the Gauge Point 15,19 on D, to 60 on C; then against 20,97 on D, is 114,28 on C, as above.

For M A L T.

Set the Gauge Point 46,36 on D, to 60 on C; then against 20,97 on D, is 12,27 on C, the Content as above.

To gauge a Cylinder.

D E F I N I T I O N.

A Cylinder is a Solid Figure, rising from a circular Base (or Circle) in right Lines, and ending in an equal Circle, or 'tis like the Rowling-Stone of a Garden.

L 2.

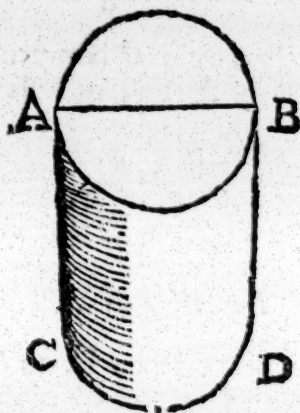
R U L E

R U L E.

Square the Diameter, and multiply that Square by the Depth; then divide by 359 for Beer Gallons, 294 for Wine, and 2737,47 for Malt Bushels.

E X A M P L E.

Let ABCD represent a Cylinder; and let AB (the Diameter) be 40 Inches, and AC the Depth = 60; what's the Content thereof in Beer, Wine, and Malt?



The Diameter 40 = AB
40

its Square = 1600
 the Depth AC = 60

Product 96000 which divide by the proper Divisors.

For B E E R.

359) 96000,000 (367,409 Content.
 24267409
 264346
 1031

For

For W I N E.

294) 96000,090 (326,530 Content.
 07826080
 195928
 1002

For M A L T.

2737,47) 96000,0000 (35,068 Content.

By the Sliding Rule.

Upon the Line D you have three Gauge Points; the first mark'd with *W. g.* for Wine Gallons, the second with *A. g.* for Ale Gallons, and the third with *M. g.* for the Malt Gauge Point; their Use is as below.

For B E E R.

Set *A. g.* = 18,94 on D, to the Depth 60 upon C, then against the Diameter = 40 on D, you'll find 267,409 as above.

For W I N E.

Set *W. g.* = 17,14 on D, to the Depth = 60 on C; then against the Diameter 40 on D, you'll find 326,530, as above.

For M A L T.

Set *M. g.* = 52,32 on D, to 60 the Depth on C; then against 40 on D, is 35,068 on C, for the Content as above.

To gauge a Cone.

D E F I N I T I O N.

A Cone is a solid Figure, rising from a circular Base
 L. 3 (CD)

The General Gauger.

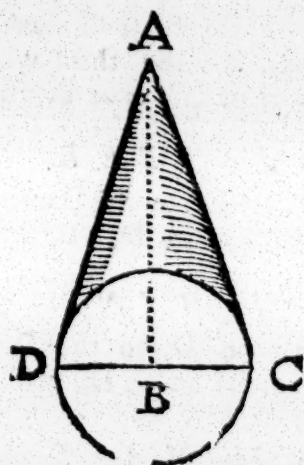
(CD) in right Lines, (CA DA) and ending in a Point, (A) which is called the Vertex or Top.

R U L E.

Square the Diameter, and multiply that Square by the Heighth; then divide by 1077 for Beer Gallons, 882 for Wine, and 8212,41 for Malt Bushels.

E X A M P L E.

Let ABCD be a Cone, whose Heighth AB is 60 Inches, and Diameter DC 40; I demand the Content in Beer, Wine, and Malt.



$$\begin{array}{r} \text{Diameter DC} = 40 \\ \hline 40 \end{array}$$

$$\begin{array}{r} \text{its Square } 1600 \\ \text{the Heighth } 60 \\ \hline \end{array}$$

the Square of the Diameter in the Heighth 96000,
which divide by 1077, by 882, and by 8212,41 for
Beer, Wine, and Malt, as below. For

For B E E R

1077) 96000,000 (89,136 the Content.
 09847398
 014992
 0365
 00

For W I N E.

882) 96000,000 (108,843 Content.

For M A L T.

8212,41) 96000,00 (11,68 Content.

By the Sliding Rule.

For B E E R.

Set the Gauge Point *A.g.* = 18,94 on D, to one third of the Heighth, *i. e.* 20 on C; then against the Diameter, *viz.* 40 on D, you'll have 89,136 as above.

For W I N E.

Set the Gauge Point *W.g.* on D, (*viz.* 17,14) to 20 ($=\frac{1}{3}$ of 60) on C; then against the Diameter, *viz.* 40 on D, you'll find 108,843 upon C, as above.

For M A L T.

Set the Gauge Point *M.g.* (52,32) on D, to 20 ($=\frac{2}{3}$ of 60) on C; then against the Diameter, *viz.* 40 on D, is 11,68 on C, as above.

To gauge a Square Pyramid.

D E F I N I T I O N.

A Square Pyramid is a solid Figure, whose Sides are
 plain

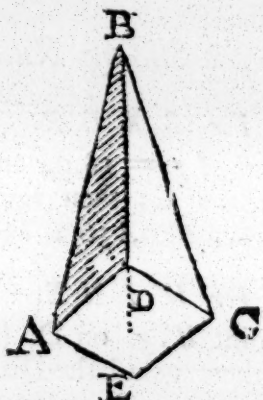
plain Triangles, and arising from a Square Base, meet in one Point at B.

R U L E.

Square the Side, and multiply that Square by the Height; then divide by 846 (= 3 Times 282) for Beer Gallons, 693 (= 3 Times 231) for Wine, and 6451,26 (= 3 Times 2150,42) for Malt Bushels.

E X A M P L E.

Let ABCDE, represent a Square Pyramid, whose Side let be 40 Inches, and Height 60; what's the Content in Beer, Wine, and Malt?



The Side $AE = CE = DC = 40$ Inches.

Its Square is
Which multiply by

$$\begin{array}{r} 40 \\ \hline 1600 \\ 60 \end{array}$$

and the Product 96000 is a Dividend,
which if you divide by 846, 693, and 6451,26 (as by
the Rule) the Quotients will be the Content in Beer, Wine,
and Malt.

For.

For B E E R.

846) 96000,000 (113,475 Content.
 11442680
 290335
 4641

For W I N E.

693) 96000,000 (138,528 Content.
 26716546
 596969
 3150

For M A L T.

6451,26) 96000,000 (14,88 Content.

By the Sliding Rule.

For B E E R.

Set 16,79 (the Gauge Point for a Square in Beer Gallons) on D, to 20 ($=\frac{1}{3}$ of 60) upon C; then against 40 (the Side given) on D, is 113,475, for the Content in Beer Gallons and Parts, as above on C.

For W I N E.

Set 15,19 (the Gauge Point for a Square in Wine Gallons) on D, to 20 ($=\frac{1}{3}$ of 60) upon C; then against the given Side, viz. 40 on D, you'll find 138,528, the Content in Wine Gallons and Parts, as above on C.

For M A L T.

Set 46,36 (the Malt Gauge Point for a Square) on D, to 20 ($=\frac{1}{3}$ of 60) on C; then against the given Side, viz. 40 on D, you'll find 14,88 on C, the Content in Malt Bushels and Parts, as above.

To

To gauge a Parabolick Conoid.

D E F I N I T I O N.

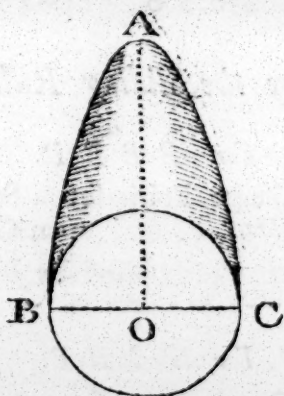
A Parabolick Conoid is made up of an infinite Number of Circles, whose Area's are in Arithmetick Progression, and formed by the Rotation of a Semi-parabola, &c.

R U L E.

Multiply the Square of the Diameter by the Heighth, and divide the Product by 718 for Beer Gallons, .588 for Wine, and 5474.94 for Malt Bushels.

E X A M P L E.

Let ABC be a Parabolick Conoid, whose Diameter BC is 40 Inches, and Heighth AO 60; what's the Content thereof in Beer and Wine Gallons, and Malt Bushels?

**D E F I N I T I O N.**

The Diameter BC is	40 Inches
	<u>40</u>
its Square is	1600
the Heighth AO is	<u>60</u>

the Rect. of the Heighth in the Sq. of the Diam. 96000
which divide according to the Rule, as below.

For

The General Gauger.

119

For B E E R.

718) 96000,000 (133,704 Content.
24266408
260342
5035

For W I N E.

588) 96000,000 (163,265 Content.
37226420
195818
1331

For M A L T.

5474,94) 96000,000 (17,53 Answer.

By the Sliding Rule.

For B E E R.

Set 18,94 (the Beer Gauge Point for a Circle) on D, to 30 (*i. e.* one Half of the Heighth, *viz.* 60) on C; then against 40 (the Diameter) on D, you'll find 133,704, the Content in Gallons and Parts on the Line C.

For W I N E.

Set 17,14 (the Gauge Point for a Circle in Wine Gallons) on D, to 30 (*i. e.* Half the Heighth, *viz.* 60) on C; then against the Diameter, *viz.* 40 on C, you'll find 163,265, the Content required on C.

For M A L T.

Set 52,32 (the Malt Gauge Point for a Circle) on D, to 30 (*i. e.* Half the Heighth, *viz.* 60) on C; then against 40 (the Diameter) on D, you'll find 17,53, the Content required on C.

To

To gauge an Hyperbolick Conoid.*DEFINITION.*

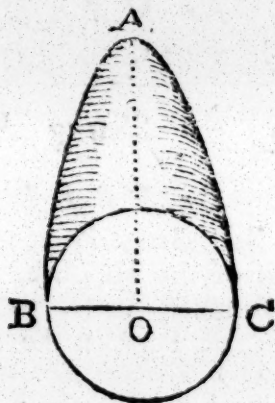
An Hyperbolick Conoid is made by the Rotation of a Semi-hyperbola about its *Axe*.

RULE.

Multiply the Square of the Diameter by the Height, and then divide that Product by 862 for Beer Gallons, by 706 for Wine, and 6569,9 for Malt Bushels.

EXAMPLE.

Let ABOC represent a Hyperbolick Conoid, whose Height AO let be 48 Inches, and Diameter BC 26; what's the Content in Beer and Wine Gallons, and Malt Bushels?



The Diameter BC, is

26 Inches.

26

156

52

676

48=Height,

5408

2704

the Rect of the Sq. of the Diam. & Height is 32448

For

The General Gauger.

121

For B E E R.

862) 32448,00 (37,64 Content.
658482
5563
32

For W I N E.

706) 32448,00 (45,96 Content.
420864
6722
40

For M A L T.

6569,9) 32448,00 (4,938 Content.

By the Sliding Rule.

For B E E R.

Set 29,36 (the Beer Gauge Point for a Hyperbolick Conoid) on D, to the Heighth, viz. 48 Inches on C; then against 26 (the Diameter) on D, you'll find 37,64 on C, as above.

For W I N E.

Set 26,57 (the Wine Gauge Point for a Hyperbolick Conoid) on D, to the Heighth, viz. 48 Inches on C; then against the Diameter, viz. 26 on D, you'll find 45,96, the Content required on C.

For M A L T.

Set 81,05 (the Malt Gauge Point for a Hyperbolick Conoid) on D, to 48 on C; then against 26 on D, you'll find 4,938, the Content in Bushels and Parts, as above.

M

To

*The General Gauger.***To gauge a Spheroid.****DEFINITION.**

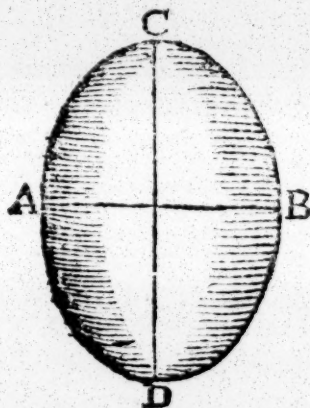
A Spheroid is an oval Solid, longer than it is broad or deep, being made by the Rotation of a Semi-Ellipsis.

RULE.

Multiply the Square of the Conjugate by the transverse Diameter; then divide the Product by 538 for Beer Gallons, 441 for Wine, and 4106,2 for Malt.

EXAMPLE.

Let ABCD be a Spheroid, whose conjugate Diameter AB is 42 Inches, and transverse Diameter CD 60; I demand the Content in Beer, Wine, and Malt,



The Conjugate (or shortest) Diameter, viz. AB is	42
	42
	84
	168

Its Square is

The Transverse (or longest) Diameter is DC =	60
	1764

The Dividend is

Which if you divide by the Divisors as in the Rule,	105840
---	--------

you'll have the Content of the Spheroid in Beer and Wine Gallons, and Malt Bushels.

For

The General Gauger.

123

For B E E R.

538) 105840,00 (196,72 the Content in Beer
5202244 Gallons and Parts.
36956
314

For W I N E.

441) 105840,00 (240 the Content in Wine Gal-
17600 lons.
000

For M A L T.

4106,2) 105840,00 (25,77 the Content in Bush-
els and Parts.

By the Sliding Rule.

For B E E R.

Set 23,19 (the Beer Gauge Point for a Spheroid) on D, to the transverse Diameter, viz. 60 on C ; then against the conjugate Diameter, viz. 42 on D, you'll find 196,72 on C, the Content required as above.

For W I N E.

Set 21 (the Wine Gauge Point for a Spheroid) on D, to the transverse Diameter, viz. 60 on C ; then against 42 on D, you'll find 240 on C, for the Content as above.

For M A L T.

Set 64,07 on D, to 60 on C ; then against 42 on D, is 25,77, the Content required on C.

M 2

To

To gauge a Globe.

DEFINITION.

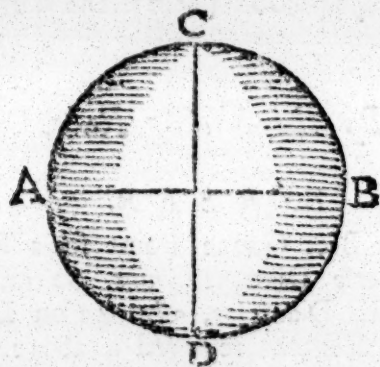
A Sphere or Globe is a round Solid, whose Length, Breadth, and Depth, is alike or equal.

RULE.

Cube the Globe's Diameter; then divide that Cube by 538 for Beer Gallons, 441 for Wine, and 4106,2 for Malt Bushels.

EXAMPLE.

Let ABCD represent a Globe, whose Diameter AB or CD is 36 Inches; I demand the Content in Beer and Wine Gallons, and Malt Bushels.



The Diameter AB=CD is

Its Square is

Its Cube (for a Dividend) is

$$\begin{array}{r}
 36 \text{ Inches.} \\
 36 \\
 \hline
 216 \\
 108 \\
 \hline
 1296 \\
 36 \\
 \hline
 7776 \\
 3888 \\
 \hline
 46656
 \end{array}$$

For

For B E E R.

538) 46656, (86,72, the Content in Beer Gal-
 36184 lons and Parts.
 386

For W I N E.

441) 46656,00 (105,79, the Content in Wine:
 0255131 Gallons and Parts.
 25526
 342

For M A L T.

4106,2) 46656,0000 (11,36, the Content in
 Bushels and Parts.

By the Sliding Rule..

For B E E R.

Set 23,19 upon D, to 36 upon C; then against 36 on
 D, you'll find 86,72 on C, the Content required.

For W I N E.

Set 21 on D, to 36 on C; then against 36 on D, you'll
 find 105,79 on C, the Content required.

For M A L T.

Set 64,07 on D, to 36 on C; then against 36 on D,
 you'll find 11,36 on C, the Content required; where you
 may observe, that the same Divisor and Gauge Point
 serves both the Globe and Spheroid, they being the same
 Part of their circumscribing Cylinder.

To gauge an elliptick Cone..

D E F I N I T I O N.

An elliptick Cone is a solid Figure, arising from an el-
 M. 3. lipticall

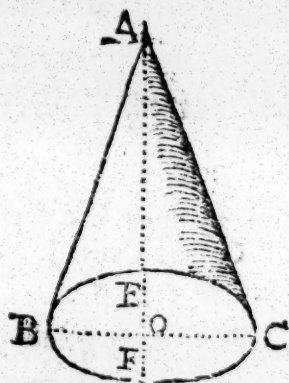
liptical Base in straight Lines, and ending in a Vertex or Point as A.

R U L E.

Multiply the Rectangle of the bottom Diameters by the Heighth; then divide by 1077 for Beer Gallons, 882 for Wine, and 8212,41 for Malt Bushels.

E X A M P L E.

Let BACO represent an upright elliptick Cone; the conjugate Diameter of its Base is 30 Inches, the Transverse 40, and Heighth AO 60; what's the Content in Beer, Wine, and Malt?



The Transverse Diameter BC is.	40 Inches.
The Conjugate Diameter EF is	<u>30</u>
Their Rectangle is	1200
Which multiply'd by the Alt. AO=60, gives 72000 for a Dividend.	

For B E E R.

1077) 72000,00 (66,85 the Content in Beer
0738845 Gallons and Parts.

09165

052

0

For

For W I N E.

882) 72000,00 (81,63, the Content in Wine
 144884 Gallons and Parts.
 5583
 22

For M A L T.

8212,41) 72000,0000 (8,767 the Content in
 Malt Bushels and Parts.

By the Sliding Rule.

For B E E R.

First, find a mean Proportional between the Diameters, viz. 30 and 40, which (by the Sliding Rule) you'll find to be 34,64: Then set 32,82 (the Beer Gauge Point for round Pyramids) on D, to 60 (the Height) on C; then against 34,64 (the mean Diameter) on D, you'll find 66,85 (as above) on C.

For W I N E.

Set 29,7 (the Wine Gauge Point for round Pyramids) on D, to 60 on C; then against 34,64 (the Mean) on D, you'll find 81,63 on C, as above.

For M A L T.

Set 90,62 on D, to 60 on C; then against 34,64 on D, you'll find 8,767 on C, as above.

To gauge the Frustum of a Cone.

D E F I N I T I O N.

If a Cone, Conoid, or Pyramid, be cut by a plain Parallel to the Base; that which remains below, is called the Frustum of a Cone, Conoid, &c.

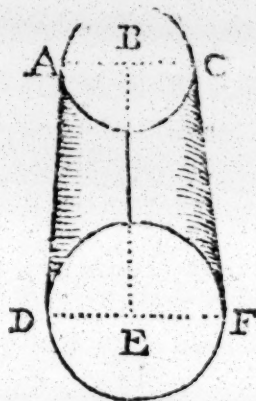
R U L E

*The General Gauger.**RULE. I.*

To three Times the Rectangle of the Diameters, add the Square of their Difference, multiply the Sum by the Depth, and divide by 1077 for Beer Gallons, 882 for Wine, and 8212,41 for Malt Bushels.

EXAMPLE.

Let ABCDEF, represent the Frustum of a Cone; let the Top Diameter, viz. AC be 30 Inches, the Bottom Diameter DF 40 Inches, and the Depth BE 60; what's the Content in Beer and Wine Gallons, and Malt Bushels?



For B E E R

The Bottom Diameter is	40 Inches
The Top Diameter is	30
Their Rectangle is	1200
	3
Three Times the Rectangle or Product is	3600
The Sq. of the Difference of the Diameters is	100
The Sum is	3700
The Depth is	60
The Dividend is	222000

1077) 222000,00 (206,12, the Content in Beer
 00660836 Gallons and Parts.
 66307.
 0138
 00

For

For W I N E.

882) 222000,000 (251,700 Content in Wine
 4560860 Gallons and Parts.
 15106
 600

For M A L T.

8212,41) 222000,0000 (27,03 Content in Malt
 Bushels.

R U L E II.

Take the Area of the greater Base, the Area of the lesser, and a Geometrical Mean between the two Area's; the Sum of these Three multiplied by one third Part of the Tun's Depth, gives the Content: And this is a general Rule for the Frustum of any Pyramid, whose Bases are Parallel, whether they are square, triangular, circular, &c.

E X A M P L E.

Let the Tun be the same as above, whose Top Diameter is 30 Inches, the Bottom 40, and the Depth 60; what's the Content in Beer, Wine, and Malt?

The Area of the Top Diameter (*viz.* 30) is 2,5069
 The Area of the Bottom Diameter (*viz.* 40) is 4,4568
 The Mean between the two Area's is 3,3425

Their Sum is 10,3062
 This Sum, *viz.* 10,3062, must be multiplied by 20

The Content required in Beer Gall. and Parts 206,1240

For

*The General Gauger.**For W I N E.*

The Area of the Top Diameter (*viz.* 30) is 3,0612
 The Area of the Bottom Diameter (*viz.* 40) is 5,4421
 The Geometrical Mean between the 2 Areas is 4,0815

Their Sum is 12,5848
 20

Which multiply'd by $\frac{1}{3}$ of 60, *viz.* 20, gives } 251,696
 the Content.

For M A L T.

The Area of the Top Diameter (*viz.* 30) is 0,3287
 The Area of the Bottom Diameter (*viz.* 40) is 0,5845
 The Geometrical Mean between the 2 Areas is 0,4384

Their Sum is 1,3516
 Which being multiply'd by $\frac{1}{3}$ of the Height, } 20
 60, *i. e.* 20, will give the Content in }
 Bushels and Parts. 27,032

*By the Sliding Rule.**For B E E R.*

Set 18,94 (the Beer Gauge Point for a Circle) on D, to 1 upon C; then against any Diameters on D, is the Area on C.

Thus against 30 on D, you'll find its Area. 2,5069

And against 40 on D, its Area. 4,4568

Then (by *Prob.* 1. in the Use of the Square }
 Root by the Rule before-going) find a Mean } 3,3425
 between the Areas.

Their Sum is 10,3062

Which by the Lines A and B, multiply by 20, and the
 Product will be 206,1240, as above. For

For W I N E.

Set 17,14 on D, to 1 on C; then against 30 on D, is 3,0612
 And against 40 on D, you'll find 5,4421
 The mean Proportion between these two Areas is 4,0815

Their Sum is 12,5848

Then set 1 upon B, to 12,5848 on A; and against 20 on B, you'll find 251,6960, as above; and the same must be observed for Malt, Respect had to the proper Gauge Point.

To gauge the lower Frustum of a parabolick Conoid, cut Parallel to the Base.

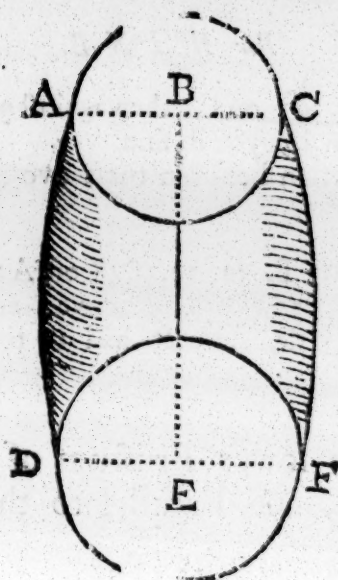
R U L E.

Add the Areas of the Diameters together, and multiply that Sum by Half the Heighth; so is the Product the Content of such a Tun.

E X A M P L E II.

Let ABCDEF represent the lower Frustum of a parabolick Conoid, whose Top Diameter is 30 Inches, the Bottom Diameter 40, and the Depth 60; what's the Content of the Tun in Beer and Wine Gallons, and Malt Bushels?

For



For B E E R.

Top Diameter 30
30

359) 900,0000 (2,5069 Area of the Top
 1825069 Diameter.
 02542
 232

Bottom Diameter 40
40

359) 1600,0000 (4,4568 Area of the Bot-
 1644568 tom Diameter.
 20498
 220

The Sum of the two Areas is 6,9637 which multiply'd
 by Half the Depth (*viz.* 60) *i. e.* 30 gives the Con-
 tent of the Tun, *viz.* 208,9110 in Beer Gallons
 and Parts. For

The General Gauger.

133

For W I N E.

Top Diameter 30
30

$$\begin{array}{r} 294) \quad 900,0000 \quad (3,0612 \text{ Area of the Top} \\ \quad \quad 0110662 \quad \quad \quad \text{Diameter.} \\ \quad \quad 18367 \\ \quad \quad \quad 000 \end{array}$$

Bottom Diameter 40
40

$$\begin{array}{r} 294) \quad 1600,0000 \quad (5,4421 \text{ Area of the Bot-} \\ \quad \quad 1304426 \quad \quad \quad \text{tom.} \\ \quad \quad 12652 \\ \quad \quad \quad 002 \end{array}$$

The Sum is 8,5033 which multiply'd by Half the Depth,
(viz. 60) *i. e.* 30 produceth the Content of the Tun
in Wine Gallons and Parts.

255.0990

For M A L T.

Top Diameter 30
30

$$2737,47) \quad 900,000000 \quad (3,287 \text{ the Area of the} \\ \quad \quad \quad \text{Top.}$$

The Bottom Diameter 40
40

$$2737,47) \quad 1600,0000 \quad (5,845 \text{ the Area of} \\ \quad \quad \quad \text{the Bottom.}$$

The Sum of the Areas is ,9132, which multiply'd by
Half the Depth (viz. 60) *i. e.* 30 shews the Content
of the Tun to be 27,3960 Malt Bushels and
Parts.

N

By

*The General Gauger.**By the Sliding Rule.**For B E E R.*

Set 18,94 on D, to 1 upon C; then against 30 on D, is 2,5069, the Area of the Top Diameter on C; and as the Rule is now set, against 40 on D you'll find 4,4568 on C, the Area of the Bottom Diameter; then set 1 upon B, to 30 on A, and then against the Sum of the Areas on B, you'll find 208,9110 on A, the Content as above.

For W I N E.

Set 17,14 on D, to 1 on C; then against the Diameters, viz. 30 and 40 on D, you'll find 3,0612 and 5,4421 their Areas on C; then set 1 on B, to 30 on A, and against the Sum of the Areas, viz. 8,5033 on B, is 255,0990, the Content required on A.

For M A L T.

Set 52,32 on D, to 1 on C; then against 30 and 40 on D, you'll find ,3287 and ,5845 on C, their Areas; then set 1 on B, to 30 on A, and against ,9132 (the Sum of the Areas) on B, you'll find 27,3960 on A, as above.

R U L E II.

Multiply the Sum of the Squares of the Diameters by the Depth, and divide the Product by 718 for Beer Gallons, 588 for Wine, and 5474,94 for Malt Bushels.

E X A M P L E.

Let the Top Diameter be 20 Inches, the Bottom 30, and the Depth 40; what's the Content in Beer and Wine Gallons, and Malt Bushels?

For

The General Gauger.

135

For B E E R.

Top Diameter 20 Bottom Diameter 30
 20 30

Its Square 400

Its Square 900
 400

The Sum of the Square is 1300
 40

718) 52000,00 (72,42 Anf.
 17448(4
 306(4
 1(2

For W I N E.

588) 52000,00 (8843 Content in Wine
 496686 Gallons and Parts.
 2501
 23

The same Dividend, being divided by 5474,94, will quote the Content in Bushels; and the like for the Frustum of any other parabolick Conoid.

To find the Content of any Tun, whose Sides are straight, and Bases Parallelograms or Ellipses.

R U L E.

1. To the greatest Length *St*, add Half the lesser Length *op*; then multiply the Sum by the greater Breadth *qr*, reserving that Product.

2. To the lesser Length *op*, add Half the greater Length *St*; and multiply the Sum by the lesser Breadth *mn*, add this Product to that before reserved; then multiply the Sum by the Depth, and divide the Product by 846

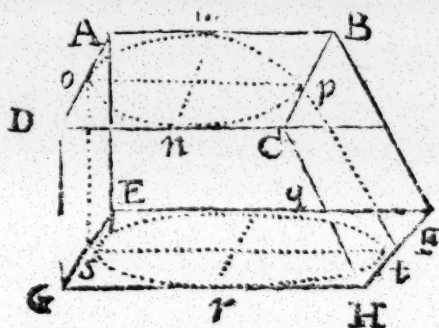
N 2

for

for Beer Gallons, and 693 for Wine, if the Bases were Parallelograms; but by 1077 for Beer Gallons, 882 for Wine, and 8212,41 for Malt, if they were Ellipses.

E X A M P L E.

Let ABCDEFGH represent a 'Tun, whose Bases are Parallel and Sides straight, in which the straight Lines at the Top and Bottom may represent a Tun, whose Bases are Parallelograms, and the curved Lines may signify the Frustum of an elliptick Cone as below.



Let the Length of the greater Base of the Tun, viz. $EF = se = GH$ be 60 Inches, and the Breadth of the same Base, viz. $EG = qr = FH$ be 30 Inches; let the Length of the lesser Base be $DC = op = AB = 52$ Inches, the Breadth of the same Base, viz. $AD = mn = BC = 46$, and the Depth $DG = os = sc.$ 39; what's the Content in Beer, Wine, and Malt.

The greater Length, i. e. $EF = sc.$ is 60 Inches.
Half the lesser Length, viz. $DC = op, sc. = 52$, is 26

Their Sum is 86

Greater Breadth, viz. $GE = rq = sc.$ is 50

The Product to be reserved is 4300

The

The lesser Length, viz. $AB = op$, &c. is 52
 Half the greater Length, viz. $EF = \text{&c.}$ is 30

Their Sum is 82
 Lesser Breadth $AD = mn = \text{&c.}$ is 46

492
 328

The Product is 3772
 The Product above reserved is 4300

Their Sum is 8072
 The Depth is 39

72648
 24216

This Product, viz. 314808 is your Dividend. Now if your Figure has elliptical Bases, your Divisors are 1077 for Beer Gallons, 882 for Wine, and 8212,41 for Malt. But if the Bases are Parallelograms, your Divisors are 846 for Beer Gallons, 693 for Wine, and 6451,26 for Malt.

To gauge the Fruustum of an upright elliptick Cone, cut parallel to the Base another Way.

R U L E.

Multiply the Product of the Top Diameters by the Product of the Bottom Diameters, and extract the Square Root of that Product; which Root add to the Sum of the said Products; multiply the last Sum by the Depth, then divide by 1077 for Beer Gallons, 882 for Wine, and 8212,41 for Malt Bushels.

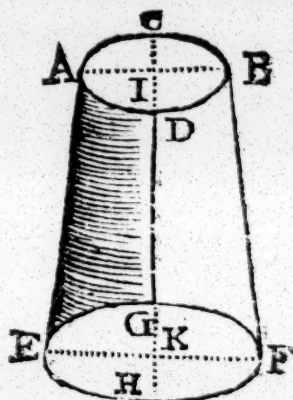
N. 3

EX

E X A M P L E.

Let ABCDEFGHIK represent the Frustum of an upright elliptick Cone, whose Dimensions are as below.

Greatest Diameter at the Top AB is	40	} what's the Content in Beer, Wine, and Malt?
Least Diameter at the Top CD is	30	
Greatest Diameter at the Bottom EF	60	
Least Diameter at Bottom GH	50	
Depth IK	66	



The greatest Diameter at the Top is	40
Least Diameter at the Top is	30

Their Rectangle or Product is	1200
-------------------------------	------

The greatest Diameter at the Bottom is	60
The least Diameter at the Bottom is	50

Their Rectangle or Product is	3000
-------------------------------	------

Rectangle of the Top Diameter is	1200
----------------------------------	------

Rectangle of the Bottom Diameter is	3000
-------------------------------------	------

Their

Their Product is 3600000,0000 (1897,36 Root)

$$\begin{array}{r}
 1 \\
 \hline
 2) \quad 260 \\
 \quad 224 \\
 \hline
 36) \quad 3600 \\
 \quad 3321 \\
 \hline
 378) \quad 27900 \\
 \quad 26509 \\
 \hline
 3794) \quad 139100 \\
 \quad 113829 \\
 \hline
 37946) \quad 2527100 \\
 \quad 2276796 \\
 \hline
 \end{array}$$

250304

Rectangle of the Top Diameters 1200
 Rectangle of the Bottom Diameters 3000
 A mean Proportional is 1897,36

Their Sum is 6097,36
 The Depth is 66

3658416
 3658416

The Dividend is 402425,76

For B E E R.

1077) 402425,76 (373,65 Content in Beer Gal-
 07933451 lons and Parts.

039087

0753

00

For

*The General Gauger.**For W I N E.*

882) 402425,76 (456,26 the Content in Wine
 4962334 Gallons and Parts.
 55374
 354

For M A L T.

8212,41) 402425,76 (49,00 Content in Bushels
 and Parts.

2. Or (according to the general Rule before given for the Fruustum of a Cone) you may find the Area of the greater Base, the Area of the lesser Base, and a mean Proportional between them; and then multiply the Sum of these by $\frac{1}{3}$ of the Height, so will the Product be the Answer.

E X A M P L E.

Let the Figure and Dimensions be the same as in the first Case; what's the Area in Beer, Wine, and Malt?

For B E E R.

As 359 is to 30, so is 40 to 3,3426 the Area of the
 30 Top Diameter

359) 1200,0000 (3,3426
 1233426
 15926
 020

As 359 is to 50, so is 60 to 8,3565 the Area of the
 60 Bottom Diameter.

359) 3000,0000 (8,3565
 1283565
 20396
 211

Area

The General Gauger.

14¹

Area of the Top	3,3426
Area of the Bottom	8,3565
A Mean	5,2851

Their Sum is	16,9842
One third of the Heighth	22

339684
339684

Content of the Tun (near that above) is 373,6524

For W I N E.

1. As 294 is to 30, so is 40 to 4,0816 Area of the Top Diameter.

2. As 294 is to 50, so is 60 to 10,2040 Area of the Bottom.

The Geometrical Mean is 6,4536

The Sum is 20,7392 which multiply
by $\frac{1}{3}$ of the Heighth (*viz.* 66) *i. e.* 22 and the Product

414784
414784

will be 456,2624 the Cont. requir'd.

For M A L T.

1. As 2737,47 is to 30, so is 40 to ,4383, the Area at the Top.

2. As 2737,47 is to 50, so is 60 to 1,0959, the Area at the Bottom.

The Geometrical Mean is ,6903

The Sum is 2,2245 which multiply by
 $\frac{1}{3}$ of the Height (*viz.* 66) *i. e.* 22 and the Product

will be 48,939 the Cont. required.

B₂

The General Gauger.

By the Sliding Rule.

For B E E R.

1. Set 359 on B, to 30 on A; then against 40 on B, is 3,3426 (the Area at the Top) on A.

2. Set 359 on B, to 50 on A; then against 60 on B, is 8,3565 (the Area of the Bottom) on A.

3. Then set 3,3426 on C, to 3,3426 on D; then against 8,3565 on C, is 5,2851 on D, for a mean Proportional; all which add to the two Areas before found, and their Sum is 16,9842; which (by the Rule) multiply'd by 22, gives 373,6, &c. the Content.

To find the Content in Wine Gallons.

1. Set 294 on B, to 50 on A; then against 40 on B, is 4,0816 (the Area of the Top) on A.

2. Set 294 on B, to 50 on A; then against 60 on B, is 10,2040 (the Area of the Bottom) on A.

3. Set 4,0816 on the Line C, to 4,0816 on D; then against 10,2040 on C, is 6,4536 (a Geometrical Mean between the two Areas) on D, which add to the said Areas, and the Sum will be 20,7392.

4. Set 1 upon B, to $\frac{1}{3}$ of the Heighth (*viz.* 66) 22 on A; then against 20,7392 on B, is 456,2624 (the Content required) on A.

For M A L T.

1. Set 2737,47 on B, to 30 on A; then against 40 on B, is the Area of the Top on A, *viz.* } 4383

2. Set 2737,47 on B, to 50 on A; then against 60 on B, is the Area of the Bottom on A, *viz.* } 1,0959

3. Set 4383 on C, to 4383 on D; then against 10,959 on C, is the Mean on D, *viz.* } 6903
The Sum is

2,2245
4. Set

4. Set 1 on B, to 2,2245 on A ; then against ,22 on B, is 48,939, the Content of the Tun in Bushels required on A : And the like may be done with a Tun, whose Bases are Parallelograms, and its Sides straight, only instead of the former Divisors ; you must make Use of 282 for Beer Gallons, 231 for Wine, and 2150 for Malt Bushels.

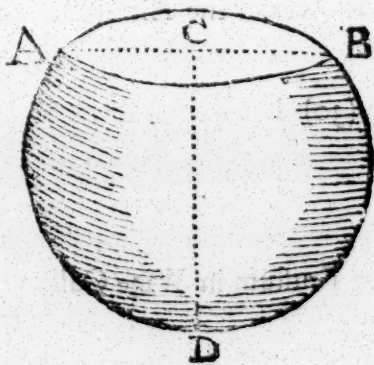
To gauge the Frustrum of a Globe.

R U L E.

To the Area of the Frustrum's Diameter, add the Area of the Heighth, more one Third of the same ; multiply the Sum by Half the Heighth, and the Product will be the Content of the Frustrum.

E X A M P L E.

Let ABCD represent the Frustrum of a Globe, whose Diameter AB let be 28 Inches, and Altitude or Depth CD 30 ; what's the Content of the Frustrum in Beer and Wine Gallons, and Malt Bushels ?



*The General Gauger.**For B E E R.*

1. As 359 is to 28, so is 28 to the Area of the Diameter, <i>i. e.</i>	}	2,1838
2. As 359 is to 30, so is 30 to the Area of the Depth, <i>i. e.</i>	}	2,5069
One third of the Area of the Heighth is		0,8356
Their Sum is		5,5263
Half the Altitude or Depth is		15
		276315
		55263
The Content of the Fruustum is		82,8945

For W I N E.

1. As 294 is to 28, so is 28 to the Area of the Diameter, <i>i. e.</i>	}	2,6666
2. As 294 is to 30, so is 30 to the Area of the Depth, <i>i. e.</i>	}	3,0612
One Third of the Area of the Alt. (<i>viz.</i> 30) is		1,0204
Their Sum is		6,7482
Half the Depth (30) is		15
		337410
		67482
The Cont. of the Fruustum in Wine Gallons		101,2230

For

The General Gauger.

145

For M A L T.

1. As 2737,47 is to 28, so is 28 to the Area of the Top ,286
2. As 2737,47 is to 30, so is 30 to the Area of the Depth ,328

One third of the Area of the Depth is ,109

Their Sum is ,723

Half the Depth is 15

3620

724

The Content in Bushels

10,855

By the Sliding Rule.

For B E E R.

Set 18,94 (the Beer Gauge Point for a Circle) on D, to 1 on C; then against the Diameter, viz. 28 on D, you'll find the Area thereof on C, i. e. 2,1838

And against the Depth, viz. 30 on D, you'll find 2,5069 on C.

The 3d of the last Area found, viz. of 2,5066 is 0,8356

Their Sum is 5,5263

Then set 1 upon B, to Half the Depth on A; and against the Sum, viz. 5,5256 on B, you'll find 82,8945 the Content required on A, i. e. 82 Gallons, 1 Pottle, 1 Quart, 1 Pint, and ,156 of a Pint.

,156

The Operation for Wine and Malt by the Sliding Rule, is in all Respects the same as above: only instead of 18,94, you must make use of 17,14 as a Gauge Point for Wine, and of 52,32 as a Gauge Point for Malt.

I have inserted the preceding Rule for this Purpose, being expeditious enough both by the Pen and Instrument,
O nay,

may, more ready and general than any other that I have taken Notice of. But if you'd have one more short, only for the Pen, take the following Rule. To three Times the Square of the Fruustum's Diameter, add four Times the Square of the Depth, multiply the Sum by the Depth, and divide the Product by 2154 for Beer Gallons, 1764 for Wine, and 1642,82 for Malt Bushels.

Of Cask Gauging.

Before we deliver Rules for this Purpose, 'twill not be amiss to let the Learner know that the Requisites are,

The Diameter at the Bung
 The Diameter at the Head } in Inches.
 And the Length

When these Dimensions are known, our next Business is to consider what the Nature or Form of the Cask we are to gauge is; for all Authors agree, that there are four Sorts, *viz.*

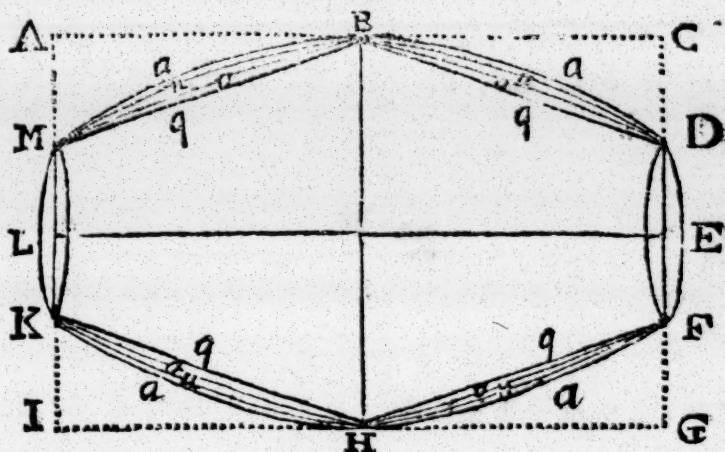
1. The middle Fruustum of a Spheroid.
2. The middle Fruustum of a parabolick Spindle.
3. The middle Fruustum of two parabolick Conoids, abutting upon one common Base; or,
4. The middle Fruustum of two Cones, abutting upon one common Base.

To these we may add, that of a Cylinder, to which all may be reduced; and though when it has the same Length as any of the Figures above-mentioned, and a Diameter the same with that of the Bung, the Content will be more than any of them, as may be seen by the next Figure following:

Yet when (by the Rules following) we think that we have reduced any given Cask to a Cylinder, 'tis such a Cylinder, whose Length is the same with that of the Cask given: But its Diameter is such, that it is greater than the Head, and less than the Bung's Diameter of the same.

This

This will be made more plain, when we see the Figures, and consult the Rules following.



1. In this Figure, ABCGHI, may represent a Cylinder whose Diameter $AI=CG$ is equal to the Bung's Diameter BH of the inscribed Casks; and consequently (as by the Figure) must contain more than any of them.

2. The middle Frustum of a Spheroid may be represented by the next inscribed Cask, viz. $Ma Ba DEFa Ha KL$.

3. The middle Frustum of a parabolical Spindle may be represented by the next inscribed Cask, viz. $Mn Bn DEFn Hn KL$.

4. The middle Frustum of two Conoids may be represented by the Casks $Mo Bo DEFo Ho KL$.

5. The middle Frustum of two Cones (being the least of all) may be represented by the Cask $Mq Bq DE Fq Hq KL$, now by this Figure 'tis plain, that a spheroidal Cask is the greatest (except the Cylinder;) the middle Frustum of a Parabolick, the next less; the middle Frustum of two Conoids, less than that; and that of two Cones, least of all, as before. This will yet appear more fully by their Contents as below.

P R O B. I.

*There's a Cask supposed to be the middle Frustum
of a Spheroid, as Ma Ba D E Fa Ha K L,
whose*

Bung Diameter BH is 40
The Head Diameter MK = DF is 30 } Inches.
And the Length LE 54
How many Ale or Wine Gallons will the Cask contain?

R U L E.

To the Sum and half Sum of the Squares of the Bung and Head Diameters, add half the Difference of the said Squares; the Sum of these multiplied by the Length, and the Product divided by 1077 for Beer Gallons, and 882 for Wine, quotes the Content respectively.

E X A M P L E.

The Squ. of BH the Bung's Diam. (<i>i. e.</i> 40) is	1600	
The Sq. of MK = DF, the Head Diam. (<i>i. e.</i> 30) is	900	
The Sum of the Squares is	2500	
Half the Sum is	1250	
Half the Difference of the Square is	350	
Sum is	4100	
Length is	54	
	164	
	205	Ale.
1077)	221400,00	(205,57
	00600551	
	60161	
	0617	
	00	
		882)

The General Gauger.

149

882) 221400,00 (251,02
 4500806
 09183
 010

Wine.

Content in Ale
 Content in Wine

205,57 }
 251,02 }

P R O B. II.

There's a Cask (of the same Diameters and Length with the former) supposed to be the middle Frustum of a parabolick Spindle, (as Mn Bn DEFn Hn KL,) how many Gallons of Ale and Wine will this Cask contain.?

R U L E.

To the Sum and half Sum of the Squares of the Bung and Head Diameters, add three Tenth Parts of the Difference of the said Squares ; multiply the Sum by the Length, and divide the Product by 1077 for Beer Gallons, and 882 for Wine.

© 3

E X A M P L E

E X A M P L E

The Sq. of BH, the Bung's Diam. (*i. e.* 40) is 1600The Sq. of MK=DF, the Head Diam. (*i. e.* 30) is 900Their Sum is 2500Half Sum is 1250The Difference of the Sq. multiplied by 3 is 210The Sum of these is 3960Length is 54158419,80Ale.

1077) 21384000 (198,55

10611455

092956

2551

00

882) 213840,00 (242,45

3746622

21939

347

Wine.

The Content in Ale Gallons and Parts is

198,55

And in Wine

242,45 fere.

P R O B. III.

There's a Cask whose Staves between the Bung and Head have but little Curvature, as M o B o D E F o H o K L, (in the last Figure,) and suppos'd to be the middle Frustum of two Conoids; what's the Area of this Cask in Ale and Wine Gallons, supposing it to have the same Diameters and Length with those above?

R U L E.

R U L E.

To the Sum and half Sum of the Square of the Bung and Head Diameters, add one Tenth of the Difference of the said Squares; then multiply the Sum by the Length, and divide the Product by 1077 for Beer Gallons, and 882 for Wine.

E X A M P L E.

The Sq. of the Bung's Diam. viz. BH = 40 is 1600
The Sq. of the Head Diam. viz. AK = DF is 900

The Sum of the Squares is	2500
Half the Sum of the Squares is	1250
One Tenth of the Difference of the Squ. is	70

The Sum is	3820
The Length is	54

1528
1910

		Ale.
1077)	206280,00	(191,53
	09855359	
	016741	
	0532	
	00	

882)	206280,00	(233,87	Wine.
	2982446		
	34786		
	766		

The Content in Ale Gallons and Parts is	191,53
And in Wine	233,87
	P R O B.

P R O B. IV.

There's a Cask in the Form of the middle Frustum of two Cones, abutting upon one common Base, as Mq Bq DEFq Hq KL, having the same Diameters and Length as those above; what's the Content in Beer and Wine Gallons?

R U L E.

From the Sum and Half Sum of the Squares of the Bung and Head Diameters, subtract Half the Square of the Difference of the Diameters themselves; then multiply the Remainder by the Length, and divide the Product by 1077 for Beer Gallons, and 882 for Wine.

E X A M P L E.

The Square of the Bung's Diam. is 1600

The Square of the Head Diam. is 900

Their Sum is 2500

Half the Sum is 1250

The Sum of these is 3750

Difference of the Diam is 10; which } squared is 100, Half of which is } 50

The Remainder is 3700

The Length is 54

148

185

1077) 199800,00 (185,51 Ale.

09214553

059567

0515

00

882

The General Gauger.

153

882) 199800,00 (226,53
 2346804
 57675
 420

Wine.

The Content in Ale Gallons and Parts is 185,51
 And in Wine 226,35

By the four preceding Problems it appears, that if the Dimensions are as in the first, *viz.* The

Bung's Diameter	40	} Inches.
Head Diameter	30	
And Length	54	

That the Content in each Variety will

By Prob.	{	1.	205,57	} Ale Gall. and	{	251,02	} Wine	
		2.	198,55			242,44		} Gallons.
		3.	191,53			233,87		
		4.	185,51			226,53		

Where we may observe, that the Difference betwixt the first and second, is the same as between the second and third; and that of the third and fourth, but a little different from the other: By which it appears, that there's not so much Room left for an Error, as was by some Rules formerly prescribed,

It can't be denied, but that a Cask having the same Diameters and Length as that above, may contain some certain Quantity between the Contents here found: However, in such Cases you may proceed by the preceding Rules, adding 1, 2, 3, 4, or 5, tenth Parts of the Difference of the Squares (as Mr. *Everard* directs) according as your Judgment, and the Shape of the Cask shall direct.

This Caution must also be observed in finding a mean Diameter, when you would reduce a Cask to a Cylinder, in order to gauge it with the Sliding Rule.

To

To guage the middle Frustum of a Spheroid another (and more expeditious) Way than is directed in the first preceding Problem.

R U L E I.

To twice the Square of the Bung's Diameter, add. once the Square of the Head ; multiply the Sum by the Length, and divide the Product by 1077 for Beer Gallons, and 882 for Wine.

E X A M P L E.

Let the Bung's Diameter be 34 Inches, the Head 24, and Length 48 ; what's the Content in Beer and Wine Gallons ?

For B E E R.

Bung's Diameter is	34	Head Diameter	24
	34		24
	136		96
	102		48
Twice its Square	2272	its Square	576
Square of the Head	576		
Their Sum is	2848		
The Length is	48		
	23104		
	11552		
1077)	138624,00	(128,71 Ale Gallons.	
	03098813		
	093643		
	0713		
	00		
			882)

The General Gauger.

155

$$\begin{array}{r}
 882) \quad 138624,00 \quad (157,17 \quad \text{Wine Gallons.} \\
 \underline{5042086} \\
 63510 \\
 \underline{160}
 \end{array}$$

$$\begin{array}{r}
 \text{Area in Beer} \quad 128,71 \\
 \text{Area in Wine} \quad 157,17 \quad \left. \vphantom{\begin{array}{l} 128,71 \\ 157,17 \end{array}} \right\} \text{Gallons.}
 \end{array}$$

To gauge a Cask taken as the middle Frustrum of a parabolick Spindle another Way.

R U L E.

To twice the Square of the Bung's Diameter, add once the Square of the Head, from the Sum take $\frac{2}{5}$ of the Square of the Difference between the Bung and Head Diameters; multiply the Remainder by the Length, and divide the Product by 1077 for Beer Gallons, and by 882 for Wine.

E X A M P L E.

Let the Dimensions be the same as in the last Example of a spheroidal Cask; what's the Content in Beer and Wine Gallons?

$$\begin{array}{r}
 \text{Twice the Square of the Bung's Diameter is} \quad 2312 \\
 \text{Once the Square of the Head is} \quad \underline{376} \\
 \text{Their Sum is} \quad 2888 \\
 \text{The Difference betwixt the Head and Bung Dia-} \\
 \text{meter is 10, its Square is 100; two Fifths of } \left. \vphantom{\begin{array}{l} 100 \\ 40 \end{array}} \right\} \quad 40 \\
 \text{which is} \quad \underline{\hspace{1cm}} \\
 \text{Remainder is} \quad 2848 \\
 \text{Length is} \quad \underline{48} \\
 \hline
 22784 \\
 11392 \\
 \hline
 \text{The Dividend is} \quad 136704 \\
 \quad \quad \quad 1077)
 \end{array}$$

The General Gauger.

1077) 136704,00 (126,93 Beer Gallons.
02906279
074023
1030
00

882) 136704.00 (154.99 Wine Gallons.
4850622
44728
882

When in Practice you would reduce any of the before-mentioned Casks to a Cylinder, you may do it near enough the Truth by the Direction following.

RULES.

Take the Difference of the Bung and Head Diameters of any Cask, and multiply that Difference by the Number which stands against the Name of the Cask given in the following Table : Add the Product to the Head Diameter, so will the Sum be the Diameter of a Cylinder ; (which being of the same Length with the given Cask, will contain as much ;) Square the Diameter thus found, and multiply that Square by the Length, and multiply that last Product by ,0028 for Beer Gallons, and ,0034 for Wine.

The Multipliers for a Cask, which is taken for
Varieties.

The middle Frustrum of	$\left. \begin{array}{l} 1 \\ 2 \\ 3 \\ 4 \end{array} \right\}$	a Spheroid	$\left. \begin{array}{l} \\ \\ \\ \end{array} \right\}$	5,7
		a para. Spin.		5,63
		two Conoids		5,56
		two Cones.		5,51

E X A M P L E.

Let a Cask be taken as the middle Frustrum of a Spheroid, the Bung's Diameter let be 20 Inches, the Head 15, and

The General Gauger.

157

and Length 24; what's the Content in Beer and Wine Gallons according to this Rule?

Bung's Diameter is 20 Inches.
Head Diameter is 15

Difference of Diameters 5
The Cask's spheroidal, therefore the Mult. is .7

The Product is 3.5
The Sum of the Pro. and Head Diameter is 18.5
18.5

925
1480
185

The Square of the Sum is 342.25
The Length is 24

136900
68450

Product is 821400
Multiplier for Beer .0028

65712
16428

The Content in Beer Gallons 22,9992

The Multiplicand 8214
The Multiplier for Wine .0034

32856
24642

The Content in Wine 27,9276 Gallons.
More

More Examples of this Kind would be superfluous; for what is said of a Cask taken as a middle Frustum of a Spheroid, may be understood of the other three, only instead of multiplying the Difference of Diameters by ,7 as above, you must use ,63, ,56, or ,51, according to the Denomination of the Cask you are to gauge.

To gauge Casks by the Sliding Rule.

Upon the Side of the sliding Rule is placed a Line of Inches, and under it the three first Varieties of Casks, *viz.* The middle Frustum of a Spheroid, the middle Frustum of a Parabolick Spindle, and the middle Frustum of two Conoids, and on some Rules the middle Frustum of two Cones is inserted upon the opposite Side to the others, and has there a Line of Inches fitted to it also: The Use of these Lines is to reduce a Cask in any of the before-mentioned Forms to a Cylinder, for which purpose you may observe the Directions following.

Let a Cask be given to be gauged in the Form of the middle Frustum of a Spheroid, having the same Dimensions as above, *viz.*

	<i>Inches.</i>	
The Bung	20	} what's the Content?
The Length	24	
And Head Diameter	15	

First, subtract the Head Diameter from that of the Bung, and (in this Case) you'll find the Difference to be 5 Inches. Find this Difference in the Line of Inches, and against that (in the Line for the first Variety) you'll find 3, and almost 5, which you may call 3,5; add this 3,5 to the Head Diameter, *viz.* 15, and the Sum, *viz.* 18,5 will be the Diameter of an equal Cylinder.

Then set 18,94 (the Gauge Point for Cylinders) on D, to the Cask's Length, *viz.* 24 upon C; then against the mean Diameters, *viz.* 18,5 on D, you'll find 22,99 on C, and

and that is the Content of the Cask in Beer Gallons required.

By this Example you may proceed to find the Content of a Cask in any other Denomination or Variety.

To find second Gauge Points, when the first will not perform the Question at one Operation.

Here we must remember, that the Divisors for a Parallelipedon was 282 for Beer Gallons, and 231 for Wine, and 2150 for Malt Bushels; and for a Cylinder, 359 for Beer Gallons, 294 for Wine, and 2737.47 for Malt; and that the Square Roots of these several Divisors are as below; which may be inserted upon the Line D, to use as Occasion requires, and are commonly called Gauge-points.

Divisors for Squares, &c. $\left\{ \begin{array}{l} 282 \text{ for Beer Gallons.} \\ 231 \text{ for Wine Gall.} \\ 2150 \text{ for Malt Bush.} \end{array} \right\}$

Gauge-points or Square Roots $\left\{ \begin{array}{l} 16.79 \text{ Beer.} \\ 15.19 \text{ Wine.} \\ 46.36 \text{ Malt.} \end{array} \right\}$

Divisors for Circles, &c. $\left\{ \begin{array}{l} 359 \text{ for Beer Gallons.} \\ 294 \text{ for Wine Gall.} \\ 2737.47 \text{ for Malt Bush.} \end{array} \right\}$

Gauge-points or Square Roots $\left\{ \begin{array}{l} 18.94 \text{ Beer.} \\ 17.14 \text{ Wine.} \\ 52.32 \text{ Malt.} \end{array} \right\}$

The Use of these Points, and others also, (which here I omit,) are sufficiently taught in the preceding Work: Where you may observe, when any of them is used in gauging Solids, that you are always to set that Gauge-point, which according to the Nature of the Figure you are to use, on the Line D, to the Length or Depth of

the Solid, on the Line C; and then against the Diameter or Side thereof on D, you have its Content on C. But in some Cases, the Content by these Gauge Points can't be found at one Operation: as for Example, suppose the Diameters of a Cylinder to be 80 Inches, and Depth 76, and the Content in Beer Gallons be required; in this Case, when I set 18 94 on D, to 76 the Depth on C, I find 80 the Diameter will fall upon no Part of the Line C; which shews, that a Cylinder having these Dimensions, can't conveniently be gauged by this Gauge-point at one Set of the Rule, without taking Half the Length, &c. And though this may serve Turn well enough, yet 'tis neither so expeditious nor artificial as when done at one Set of the Rule, without any such halving and doubling as hitherto has been used among most Officers and Others.

C A S E I.

When the Lines C and D are set even at both Ends, if you find any Gauge-point on D stand on any Part of the first *Radius* of the Line C; the second Gauge-point (to that) on D, will fall against some Part of the second *Radius* of the Line C; but to know on what Part of the Line D, the second Gauge-point will fall, take the following

R U L E.

Multiply the Square of any such Gauge-point by 40, and divide the Product by 4; then is the Square Root of the Quotient the second Gauge-point required.

E X A M P L E.

Suppose I would find a second Gauge-point to 18.94, in order to solve the preceding (or any such) Question
where

where the first proves deficient, the Square of this first Gauge point is

359,05

Which multiply by

40

and divide the Product by 4.)

14362,00

(3590,50

230200

The Quotient is 3590,5, whose Square Root is 59,92, at which you may make a Point or Prick on the Line D, for a second Gauge-point to 18,94; or in this Case, instead of multiplying the Square of the Gauge-point by 40, and dividing by 4, you may only move the decimal Point in the Square, one Place farther towards the Right Hand; so will 359,05 become 3590,5 as before. Now to answer the former Problem by the second Gauge-point, you may proceed as before, *i. e.* set 59,92 on the Line D, to the Depth of the Cylinder, *viz.* 76 on C; then against 80 the Diameter on D, you'll find the Content required, *viz.* 1354,8764 Beer Gallons on C. By the same Rule, you'll find the second Gauge-point to 17,14 for Wine, to be 54,22; at which you may also make a Point or Prick on the Line D, to use in such Cases; where the first is deficient, and so of any other Gauge-point (in the Case) whether for a Circle or Square.

CASE II.

When the Lines C and D are set even at both Ends, if you find the first Gauge-point on the Line D, to stand against any Part of the second *Radius* of the Line C; the second Gauge-point on D, will fall against some Part of the first *Radius* of the Line C; but to find upon what Place of the Line D, such a Point will fall, you may take the following

RULE.

Multiply the Square of any such (1.) Gauge-point by 4, and divide the Product by 40; (or by 10, and di-

P 3

vide

vide by 100;) then the Square Root of the Quotient will be the second Gauge-point required.

EXAMPLE.

Let 52,32 be the circular Gauge-point for Malt Bushels, and let a Cylinder, whose Diameter is 114 Inches, and Depth 20, be given to be gauged, *i. e.* the Content in Malt Bushels is required.

Set 52,32 on D, to 20 the Depth on C; then you'll find that 114 the Diameter on D, will fall on no Part of the Line C; which shews, that the Cylinder can't conveniently be gauged at one Set of the Rule by this Gauge-point; therefore another must be found, as below.

The Square of the Gauge-point, *viz.* 52,32 is 2737,3824
Which multiply by 4,
And divide by

$$\begin{array}{r} 40,) \quad 10949,52960 \quad (273,73824 \\ \quad 294952960 \\ \quad \quad 1213010 \end{array}$$

The Quotient is 273,73824, whose Square Root is 16,545 for the second Gauge-point required.

Now to gauge the Cylinder, set 16,545 on D, to 20 the Depth on C; then against 114, the Diameter on D, you'll find Malt Bushels on C, which (by this second Gauge-point) is the Content at one Set. In this Case, the Square of the second Gauge-point might have been found, if (instead of multiplying by 4, and dividing by 40) you had placed the decimal Point, one Place towards the Left-Hand in the Square of the first Gauge-point given, so would 2737,47 become 273,747.

If you would find the second Gauge-Points by the Instrument it self, you may set any Number upon the first or second *Radius* of the Line C, to the first Gauge-point on the Line D; then against the same Number made ten Times less, or ten Times more, on the *Radius* of C, will stand a Number on D, which is the Gauge-point required, and must be valued according to that Side of the first Gauge point it falls on, *i. e.* if on the left Side less, but

but if on the right Side of the first Gauge-point it will be more than it: As if it were required (instrumentally) to find a second Gauge-point to 18,94, I set 4 on the first *Radius* of the Line C, to 18,94 on D; then against 40 on the second *Radius* of the Line C, I find 59,92 on the Line D, for the Gauge-point required. *Where note*, that if you had set 1, 2, 3, 4, or 5, &c. of the first *Radius* of the Line C, to 18,94 on D; then would 10, 20, 30, 40, or 50, &c. on the second *Radius* of the Line C, fall on the same Place of the Line D, *viz.* on 59,92, as before.

To find the Ullage of a Cask.

Let the Figure following represent a Cask lying with its Axis parallel to the Horizon, partly empty: Let the Bung's Diameter (*viz.* AB) be 38 Inches, and the Content 130 Gallons: Let CB be the wet Inches=25, and AC the dry Inches=13; I demand how many Gallons are in the Cask, and how many are drawn out.

For the Solution of this and such like Problems, I have here inserted the following Table, from the 94th Page of Mr. *Ward's Gauger's Practice*; whose Use and Construction is as below.

R U L E.

Divide either the wet or dry Inches by the Bung's Diameter, and the Quotient seek in the Table under V, the versed Sine; against it stands a Number, which multiplied by the Content of the Cask, exhibits the Vacuity, if your Dividend were the dry; or remaining Liquor, if it were the wet Inches.

E X.

E X A M P L E I.

The wet Inches are 25, which divide by

$$\begin{array}{r} 38 \overline{) 25.00} \quad (.65 \\ \underline{220} \\ 3 \end{array}$$

the Quotient is ,65; and because the Remainder, *viz.* 30, is so near the Divisors, *viz.* 38, you may make the Quotient 66; which find under V, and against it, (under the Word Area) you'll find ,7002; which multiplied by the Cask's Content (*viz.* 130) produceth 91,0260, the remaining Liquor required.

E X A M P L E II.

The dry Inches are 13, which divide by

$$\begin{array}{r} 38 \overline{) 13.00} \quad .34 \text{ Quotient.} \\ \underline{168} \\ 0 \end{array}$$

Find this Quotient under V, and against it you'll find ,2998; which multiplied by the Cask's Content, *viz.* 130, produceth 38,9740, the Vacuity required, which added to the remaining Liquor, *viz.* 91,0260, makes 130, the Content, which may prove the Work to be true.

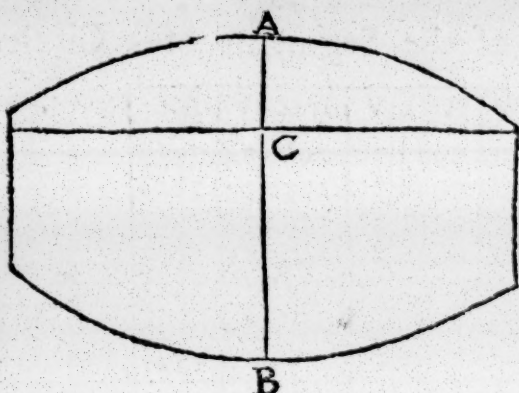
A T A-

A TABLE of the Segments of a Circle.

V	Area.	V	Area.	V	Area.	V	Area.
1	,0017	99	,9983	26	,2066	74	,7934
2	,0048	98	,9952	27	,2178	73	,7822
3	,0087	97	,9913	28	,2292	72	,7708
4	,0134	96	,9866	29	,2407	71	,7593
5	,0187	95	,9813	30	,2523	70	,7477
6	,0245	94	,9755	31	,2640	69	,7360
7	,0308	93	,9692	32	,2759	68	,7241
8	,0375	92	,9625	33	,2878	67	,7122
9	,0446	91	,9554	34	,2998	66	,7002
10	,0520	90	,9480	35	,3119	65	,6881
11	,0598	89	,9402	36	,3241	64	,6759
12	,0680	88	,9320	37	,3364	63	,6636
13	,0764	87	,9236	38	,3487	62	,6513
14	,0851	86	,9149	39	,3611	61	,6389
15	,0941	85	,9059	40	,3735	60	,6265
16	,1033	84	,8967	41	,3860	59	,6140
17	,1127	83	,8873	42	,3986	58	,6014
18	,1224	82	,8776	43	,4112	57	,5888
19	,1323	81	,8677	44	,4238	56	,5762
20	,1424	80	,8576	45	,4364	55	,5636
21	,1527	79	,8474	46	,4491	54	,5509
22	,1637	78	,8369	47	,4618	53	,5382
23	,1737	77	,8263	48	,4745	52	,5255
24	,1845	76	,8155	49	,4873	51	,5127
25	,1955	75	,8045	50	,5000	50	,5000

Here the Reader may note, that those Figures in this Table, which differ from those in Mr. *Ward's* Book above-mentioned, are placed in the room of those there which I suppose were printed false; as against the versed Sine 14 (in that Author) is, 0151 for the Area, but ought to be, 0851, as in this Table, &c.

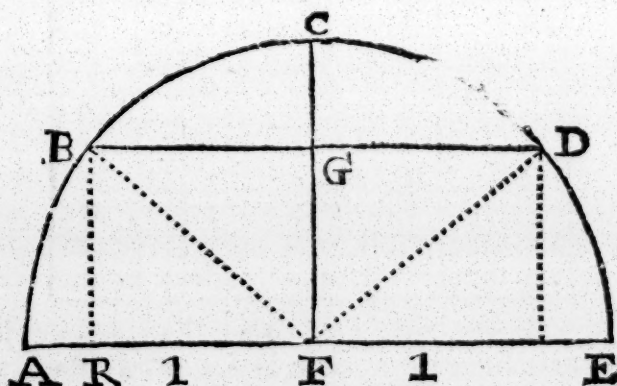
Cont.



} Cont. 130.

The Construction of the preceding Table.

In the following Figure, that Part of it which is inclosed by the right Line BD, and Arch BCD, is called the Segment of a Circle; in which GC is called the versed Sine, and BD its Chord: Also that Part of it which is inclosed by the *Radius* FB, FD, and Arch BCD, is called the Sector of a Circle, and AE the Diameter, which let be 2.



Having the Diameter $AE \equiv 2$, you may find the Circumference. Thus, as $1 : 3,14159265 :: 2 : 6,28318530$,

8530, and this 6,28318530 is the Circumference of a Circle, whose Diameter is 2; the Area of which Circle (or any other) may be found by multiplying half the Circumference, (*viz.* half 6,28318530, *i. e.* 3,14159265) by half the Diameter, (*viz.* 2, *i. e.* 1,) and the Product, (*viz.* 3,14159265) will be the Area; from whence 'tis plain, that the Length of half the Arch of any Sector of a Circle, is equal to the Area of that Sector.

When the Area of the Sector (FBCD is found,) and also the Area of the Triangle BGDF, their Difference is the Area of the Segment BCDG.

EXAMPLE.

Let it be required to find the Area of the Segment BCDG, whose versed Sine GC is 5, *i. e.* half the Radius $FC=FE=FA=1$.

First, in order to find the Area of the Sector, we must find the Quantity of the Angle at the Center, *viz.* $BFC=DFC$; to find which we have $FG=,5$, and $BG=,8659$, (*i. e.*) a mean Proportional between $AF=1$, + $FG=,5$, (*i. e.* 1,5.) Thus,

As FG (the Side of the right angled Triangle FBG right angled at G) that is, .5 or } 3,698970
 ,5000.

Is to Radius 10,000000
 So is $BG=,8659$ 3,937468

To the Tangent of 59.99, *viz.* 10,2384090
 By which it appears, that the Angle BFC in Degrees and decimal Parts is 59.99.

Now to find the Length of any Number of Degrees, (*i. e.* the Length of any Arch) of this Circle, say,

As 360 the Circumference in Degrees, is to 6,28318530, the Length of the Circumference in Inches and decimal Parts: So is 1 Degree to ,01745329, the Length of one Degree. Now the Length of any other Arch may be found thus:

As

As 1 Degree is to ,01745329 the Length thereof, so is any other Number of Degrees to the Length of their respective Arches; so that ,01745329 is a common Multiplier for any Number of Degrees; so the Degrees of the Arch BC, viz. 59,99 being multiplied by ,01745329, gives 1,0470228671 the Length of the Arch BC; Which being half the Length of the Arch BCD, must be the Area of the Sector FBCE, which was required.

To find the Area of the Triangle BGDF.

In the Figure, there's given $FG = ,5$, and $BG = ,8659$, being the Breadth and Length of the Parallelogram RBCF (which is equal to the two Triangles TGB, and TGD) to find its Content: Thus BG is

And FG is

The Area of the Parallelogram RBGF, or Triangle BFD is

From the Area of the Sector FBCE

Take the Area of the Triangle BFD

And there will remain the Area of the Segment BCDG.

But because in all Tables that are for this purpose, 'tis supposed, that the Area of the whole Circle is Unity, the preceding Table was made by this Proportion.

As the Area of the Circle, whose Diameter is 2, viz. 3,14159265 is to the Segment of any Part of that Diameter.

So is 1 (the Area of another Circle) to the Segment of the like Part of its Diameter: That is,

As 3,14159265 is to ,6140728671, (the Segment last found:) So is 1 to ,1954, the Segment answering to the versed Sine 25 in the Table.

For as the versed Sine of the first Segment, viz. GC was 5, i. e. $\frac{1}{2}$ the Radius FC; so is 25 the versed Sine of the last Segment, $\frac{1}{2}$ of ,50 the Radius of the Table:
And

And what is here said may suffice, both for the Use and Construction of the Table, which may be used when the Cask is cylindrical; but when the Bung and Head differ much, then the Line of Segments on the Sliding Rule is most convenient.

To calculate any Diameter between the Bung and Head of a spheroidal Cask, (when the Axis is perpendicular to the Horizon) whose Dimensions

are	{	AB the Length	30	} Inches.
		CD the Bung's Diameter	26	
		EF the Head's Diameter	22	

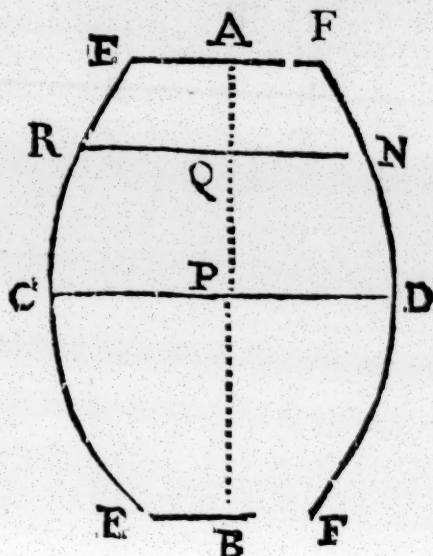
R U L E.

From the Square of the Bung's Diameter (CD,) subtract the Square of the Head Diameter (EF,) and divide the Square Root of the Remainder by half the Cask's Length (AB;) then multiply this Quotient by the Distance of the required Diameter from the Bung, which Product you may call your Subducend.

Lastly, From the Square of the Bung's Diameter, subtract the Square of your Subducend, and the Remainder is the Square of the Diameter required.

E X A M P L E.

Let it be required to find the Diameter RN, which we will suppose to be 10 Inches distant from CD, the Bung Diameter.



The Square of the Diameter CD is	676
The Square of the Head Diameter EF is	484

The Difference of the Squares is	192
----------------------------------	-----

The Square Root of the Remainder (<i>viz.</i> 192) is	13,85
--	-------

This Root, *viz.* 13,82, divided by half the Cask's Length, *viz.* 15, quotes ,92; which multiplied by 10, produceth 9,2 for the Subducend.

Square of the Bung-Diameter	676
Square of the Subducend is	84,64

There remains	591,36
---------------	--------

Which is the Square of the Diameter RN, whose square Root is 24,31, the Diameter RN itself: Having thus found the Diameter RN, you may find the Content of RNCDEF by the following

R U L E.

1. To twice the Square of the Bung-Diameter, add once the Square of the Diameter at the Liquor's Surface, (which

(which we suppose to be RN) and multiply the Sum by the Distance from the Bung-Diameter to the Liquor's Surface.

2. To twice the Square of the Bung's Diameter, add once the Square of the Head; multiply the Sum by the Distance from the Bung-Diameter to the Head, add these two Sums together, and divide their Sum by 1077 for Beer Gallons, and 882 for Wine.

E X A M P L E.

The Square of the Bung's Diameter	676
	<u>676</u>
Twice the Square of the Bung's Diameter is	1352
The Sq. of the Diam. at the Liquor's Surface, viz. RN	<u>591,36</u>
Their Sum	19433,36
Which multiply by 10, the Distance of RN from CD	<u>10</u>
The Product is	19433,60
Twice the Square of the Bung's Diameter is	1352
The Square of the Head is	<u>484</u>
Their Sum is	1836
Which Sum multiplied by Half the Length, i. e.	<u>15</u>
	9180
	<u>1836</u>
Product	27540
To which add the Product before found, viz.	<u>19433,60</u>
Their Sum is	46973,60
Which Sum you may divide by 1077 for Beer Gallons, and 882 for Wine, as above directed; and 8212,41 for Malt (if it be a Calk cut off parallel to the Bung-Diameter.)	
	Q 2
	For

*The General Gauger.**For B E E R.*

1077) 46973,60 43,61 the remaining Liquor
 038924(3 in Beer Gallons.
 0666(6
 01(5
 (0

For W I N E.

882) 46973,60 (53,25 the Content in Wine
 28772(0 Gallons and Parts.
 221(1
 5(7

Now having by the fore-going Rules found the Quantity of the remaining Liquor in Beer Gallons to be 43,61 you may take it out of the Cask's whole Content, *viz.* 51,14 Gallons, and there will remain 7,5; which may inform you, that the Liquor drawn out is 7,53 Gallons, or it will want so much to fill it up: Where you may note, that if the Liquor's Surface had been below the Bung, the Difference of the Sums would have been your Dividend.

A more speedy Way to find the remaining Liquor or Vacuity of a spheroidal Cask, posited with its Axis perpendicular to the Horizon, or standing at one End.

R U L E.

Divide the wet or dry Inches by the Cask's Length, and if the Quotient exceeds ,5000, add to the said Quotient one tenth Part of the Excess: But if it be under ,5000, subtract one tenth Part of the Want; so will the Sum or Remainder be a decimal Number; by which, if you multiply the Content of the Vessel, the Product will be

be the Quantity of Liquor therein, if your Dividend was the wet Inches; but the Quantity of Liquor which is required to fill it up, if the Dividend was the dry Inches: But observe, that the decimal Places in the Dividend, must exceed those in the Divisor (if any be) by 4 Places, and the same Caution must be observed in the next Rule.

E X A M P L E.

Bang Diameter	28	}	Ale Gall.	}	Wet Inches	18	
Head	22		}		Content 60,96	}	Dry Inches 14
Length	32						

Wet Inc. Quot.

Length 32) 18,0000 (,5625 this exceeds ,5000 by 0625,
 ,20860 ,00625 one tenth of which is 00625
 010 —

The Sum is ,56875 a Multiplicand, or, &c.

The Cont. of the Cask is 60,96

341250
 511875
 341250
 ———

Liqu. in the Cask 34,6710000

To find the Vacuity or Quantity of Liquor
 that the Cask wants to fill it up.

*The General Gauger.**E X A M P L E I.*

Dry Inches.

The Length 32) 14,0000 (,4375 this wants ,0625 of 5000,
 12460 ,00625 is one Tenth of ,0625.

210

This Remainder ,43125 the Multiplier, or, &c.
 The Casks, whose Cont. is 60,96

258750
 388125
 258750

There want's to fill it up 26,2890000, to which add the
 Liquor in the Cask 34,6710000, and the Sum will

be the Cont of the Cask 60,9600000 when full; which
 may serve as a Proof to both Operations.

E X A M P L E II.

Length 32 } What Quantity of Liquor is in.
 Wet Inches 28 } the Cask, and how much will fill
 Dry 4 } it up?

Wet Inches.

Length 32) 280000 (,8750 this exceeds, ,5000 by ,3750
 24600 ,0375 is one Tenth of 3750

100

Sum is ,9125 for a Multiplier, or, &c.
 Content 60,96

54750
 82125
 54750

The Gallons are 55,626000 which are now in the Cask.
 Dry

Dry Inches.

Length 32) 4,0000 (,1250 this wants ,3750 of ,5000
 0860 ,0375 is one Tenth of ,3750

100

The Diff. Rem. is ,0875 for a Multiplier, or, 6.

The Cask's Content is 60,96

5250

7875

5250

wants to fill the Cask 5,334000

there is in the Cask 55,626000

their Sum is the Cont. 60,960000 for Proof.

To find the Ullage of a Cask which lies on one Side, or with its Axis parallel to the Horizon.

R U L E.

Divide the wet or dry Inches by the Bung's Diameter ; if the Quotient be above ,5000, add to it one fourth Part of the Excess, and multiply the Sum by the Cask's whole Content. But if it be under ,5000, take from it one fourth Part of what it wants, and the Remainder will be a decimal Fraction, which multiplied into the Content, exhibits the Thing required.

E X A M P L E.

Let the Cask be the same as before, only in another Position.

Bung-Diameter	28	}	Ale Gall.	}	Wet	21	}	Inch.						
Head	22								}	Content	60,96	}	Dry	7
Length	32													

what's in the Cask,
 and what will fill
 it up.

Wet

Wet Inches.

Bung 28) 21,0000 (,7500 this exceeds ,5000 by ,2500
 14000 ,0625 is one fourth Part of ,2500
 000 —

The Sum is ,8125 for a Multiplier, or, &c.

The Cont. of the Cask is 60,96

48750

73125

48750

The Li. in the Cask is 49,530000

Note, That if the Quotient proves under ,5000, or above ,8000, instead of one fourth Part, add or subtract one fifth Part.

To find the Vacuity, or Quantity of Liquor that the Cask wants to fill it.

Dry Inches.

Bung 28) 7,0000 (,2500 this wants ,2500 of ,5000
 14000 ,0625 is one fourth Part of ,2500
 000 —

The Difference is ,1875 for a Multiplier, or, &c.

the Cask's Content is 60,96

11250

16875

11250

There wants to fill

the Cask

11,430000.

To which add

the contained Liq.

49,530000

the Cask's Content 60,960000

If the Cask you are to ullage be a Cylinder, or near that Form, the preceding Rule will be very near the Truth; but if the Bung-Diameter be much greater than the Head Diameter, then instead of one fourth Part (as above) you must add or subtract but one third Part, and multiply the Sum or Remainder by the Content; so will the Product be what is required.

E X A M P L E.

Let the Content of a Cask that bulges much, be 60 Gallons.

The Bung-Diameter	26	} Inches.
Wet	10	
Dry	16	

To find the Vacuity.

	Dry Inches.	
Bung 26)	16,0000	(,6153 exceeds ,5000 by ,1153
	04402	,0384 is $\frac{1}{3}$ of ,1153
	112	
	Sum	,6537
	Content	60
	Vacuity	39,2220 Gallons.

To ullage a Cask by the Sliding Rule, when its Axis is parallel to the Horizon.

Let a Cask be in the Form of a middle Frustum of a Spheroid. Inches.

Whose Bung is	30	} Content 80,58	} Gall.	} Wet 18	} Dry 12	} Inches.
Head	22					
Length	38					

what's the Vacuity, and contained Liquor?

To

To answer this Problem, or any other of the like Nature, you have a Line of Segments upon the same Side of the Rule with the Lines A and B, which Line is noted at the right End with Seg. *l*, which may signify a Line of Segments for a lying Cask. To this Line belongs a Line of Numbers marked at the right End with Number. The Use of both are as below.

1. Set the Bung's Diameter, *viz.* 30 upon the Line of Numbers, to 100 on the Line of Segments; then against the wet Inches, *viz.* 18, on the Number, you'll find 63,9 on the Line of Segments, which keep.

2. Set 100 upon the Line B, to the Cask's Content, *viz.* 80,58 on A; then against the Number last found, *viz.* 63,9 on B, you'll find 51,49 Gallons; and so many Gallons are now in the Cask, because you made Use of the wet Inches. But to know how many it wants of being full,

1. Set the Bung's Diameter, *viz.* 30 on the Line of Numbers, to 100 on the Line of Segments; then against the dry Inches, *viz.* 12 on the Line of Number, you'll find 36,1 on the Line of Segments, which keep.

2. Set 100 on the Line B, to the Cask's Content, *viz.* 80,58 on A; then against the Number last found, *viz.* 36,1 on B, you'll find 29,09 Gallons on the Line A, and so much is the Vacuity, because you used the dry Inches.

To prove which

The Vacuity is	29,00	
The contained Liquor is	51,49	
Their Sum is the Content	80,58	and according to these two Examples you may proceed to ullage any other lying spheroidal Cask.

To ullage a spheroidal Cask, when its Axis is perpendicular to the Horizon, or standing on one End, by the Sliding Rule.

For this Purpose you have a Line of Segments for a standing Cask on the same Side of the Rule with the Lines C and D, (if the Line of Cubes herein before described is not there,) noted with Seg. *St* against which is placed a Line of Numbers, both use as below.

Let the Cask be the same as in the last, only in another Position.

	Inches.		Gall.		
Bung	30	} Cont.	80,58	Wet Inches	23
Head	22			Dry Inches	15
Length	38			the Vacuity and contained Liquor ?	
					what's

1. For the contained Liquor, set the Cask's Length, *viz.* 38 on the Line of Numbers, to 100 on the Segments; then against 23 the Wet Inches on the Line of Numbers, you'll find 61,5 on the Line of Segments, which keep.

2. Set 100 on B, to the Cask's Content, *viz.* 80,58 on A; then against the Number last found, *viz.* 61,5 on B, you'll find 49,57 on A, and so much Liquor is now in the Cask.

For the Vacuity, or the Liquor wanting to fill the Cask.

1. Set the Cask's Length, *viz.* 38 on the Numbers, to 100 on the Segments; then against 15, the dry Inches on the Numbers, you'll find 38,2 on the Segments, which keep.

2. Set 100 upon B, to the Cask's Content, *viz.* 80,58 on A; then against 38,2, the Number last found on B, you'll find 31,01 the Quantity of Liquor required to fill the Cask.

Here (and so in the last, *i. e.* a lying Cask) you must observe, that if you would find the Quantity of Liquor that is in any Vessel of this Kind, you must set the Bung or Length to the wet Inches; But if the Vacuity, you must set them to the dry, according as the Cask is posited.

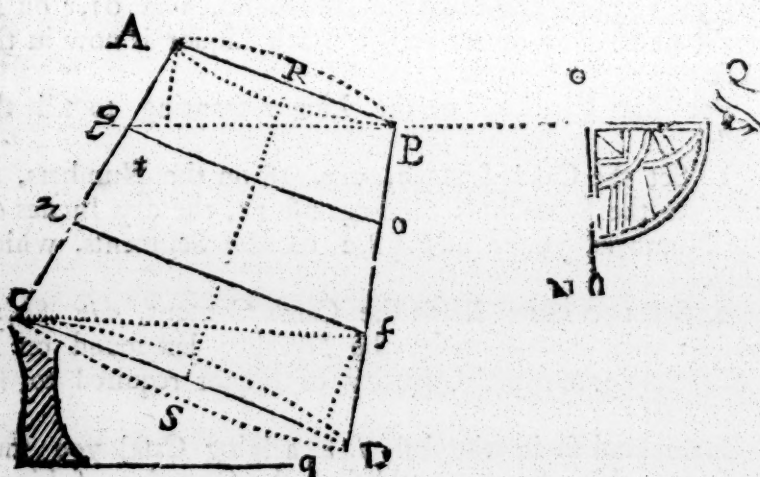
To

To find the Drip or Fall of a Tun.

Suppose a conical Tun (as ABCD) to be so posited, as to have its Axis RS inclining towards the Horizon, so that when the Liquor just touches the Angle at C, (made by the bottom Diameter CD, and Side of the Cone AC,) it may wet 20,14 Inches of the opposite Side BD, viz. Df, or when filled so as to touch B, may want 18 Inches (on the opposite Side) of the Top as A.g; let the Dimensions of the Tun be first,

The Top Diameter AB	90,	} Inches.
Bottom Diameter CD	106,	
Depth RS	60,	
Slanting-side AC or BD	60,53	

According to these Dimensions, the
 Content of the Tun in Beer Gallons and Parts is } 1608,69 Gallons



When this Tun is (for Conveniency of cleansing) so posited as above, and Liquor poured in until it touches the Top-Diameter at the Edge B, the Surface of that Liquor may

quor may be represented by the Line Bg ; by which it appears, that the Part of the Tun ABg , will be empty; and so the Tun will want so much of its whole Content; but to know how much that is, should be our next Business.

In order to do this, we should know how many Inches and Parts the Surface of the Liquor at g wants of the Top of the Tun at A ; which you may easily find (if the Tun be filled up to B ;) by measuring from A , to the Liquor at g . But if there is no Liquor in the Tun, you may proceed to know where the Point g would fall (nevertheless) by the Directions following.

Take a Quadrant, and direct the Sights by the Top of the Tun at B , to the opposite Side AC , still elevating or depressing the same, until the Thread oN , falls on the Beginning of the first Degree on the Limb; which it will do when you see the white Speck at g , made with Chalk, &c. or you may fasten a Line at B , and extend it to the opposite Side AC , holding it very tight; then bring it nearer or farther from the Top at A , until applying the Horizontal Radius of your Quadrant to the said Line, the Thread may fall on the Beginning of the first Degree, which it will not do till brought to the Point g , as before.

Having thus found the Point g , you may with your Rule take its true Distance from the Point A , which we'll suppose to be 18 Inches. So have you the top Diameter AB , and Slanting-side Ag , of the Frustum of a Cone $ABgo$, to find the bottom Diameter go , and perpendicular Depth At ; which you may truly do by Calculation, according to the Directions following.

The Reason of which depends upon *Prop. 4. of Euclid 6.* (as above cited) where 'tis demonstrated, that the Sides of equiangular Triangles are proportional.

To find the Diameter $g o$.

R U L E.

From the bottom Diameter CD, <i>viz.</i>	106 Inches.
Subtract the top Diameter, <i>viz.</i> AB=	90

And there will remain

16

One Half of which is

8

Then say, as the Slanting-side $AC = 60,53$, is to Half the Difference of the Diameters AB and $CD = 8$; so is the Slanting-side $Ag = 18$, to Half the Difference of the Diameters AB, and $g o = 2,37$, which doubled, and added to the Diameter $AB = 90$, will be $94,74$, the Diameter $g o$ required,

To find the Depth $A t$, of the Fruustum $AB g o$.

R U L E I.

Say, as the Slanting-side $AC = 60,53$, is to the Depth of the whole Fun $RS = 60$; so is the Slanting-side $Ag = 8$, to its proper Part of the Depth, *viz.* $A t = 17,84$ required.

Having thus found the Depth $A t$, and Diameter $g o$, of the Fruustum $AB g o$, you may find what the Part $AB g A$ will contain by the following

R U L E II.

To the Square of the top Diameter $AB = 90$, add one Half of the Rectangle, or Product of the top and bottom Diameters; multiply the Sum by the Depth, ($A t$) and divide the Product by 1077 for Beer Gallons, and 882 for Wine.

E X-

E X A M P L E.

The Square of the Top Diameter, viz. AB is 8100
 Half the Product of $g o = 94,74$ into $AB = 90$ is 4263,30

Their Sum is 12363,30
 Which multiply by the Depth $A z =$ 17,84

4945320
 9890640
 8654310
 1236330

1077) 220561,272 (204,792 Gallons.
 005163348
 515948
 08922
 000

The Content of the whole Tun ABCD in Ale Gallons is

1208,69

The Content of the Part AB $g A$

204,792

The Tun when fill'd to the Edge B, contains 1003,898

If you'd know how many Gallons is contained in the Part B $g o B$, being the lower Part of the Frustrum AB $g o$, you may be satisfied by the following

R U L E III.

To the Square of the Bottom Diameter, ($g o$) add Half the Rectangle or Product of the bottom Diameter into the top Diameter; (*i. e.* $\frac{1}{2} g o + AB$) then multiply the Sum by the Depth, and divide the Product by 1077 for Beer Gallons, and 882 for Wine.

R 2

E X-

EXAMPLE.

The Sq. of the bot. or lower Diam. $94=94,74$ is 8975,6676
 Half the Rect. of the Dia. $AB=90$, in $90=94,74$ is 4263,30

Their Sum is

13238,9676

Which you must multiply by the

Depth $At=17,84$, and the Product will be } 236183,181984

Divide it by 1077, and the Quotient in Ale Gallons is 219,29729; and so much will the Part $BgoB$ contain, Q, E, F.

To find how much Liquor must be poured into the Tun (as it now stands) to cover the Bottom CD , take the Rules following.

To do this, you must first (by the preceding Directions) find Ag , which is equal to Bo , and the Diameter go ; which done, you may proceed to find Df : Thus,

Say, as $go=94,74$, is to $CD=106$, so is $Bo=Ag=18$, to $Df=20,14$; and so much of the Side BD will be wet, when the Liquor comes to touch at C .

To find the Diameter fw .

First add $WC=fD=20,14$, to $Ag=Bo=18$, and their Sum is 38,14; which take from $AC=BD=60,53$, and there will remain $gw=fO=22,39=fw$. Add to $Ag=Bo=18$, and the Sum will be $Aw=Bf=40,39$. Then say,

As $AC=BD=60,53$, is to Half the Difference of the Diameters, (*viz.* $AB=go$, and $CD=106$.) *i. e.* 8, so is $Aw=Bf=40,39$, to Half the Difference of the Diameters

ters AB and wf , i. e. 5,34; which doubled, and added to AB=60, gives 100,68 for the Diameter fw required.

To find the Depth $f q$, of the Fruustum wf CD, say,

As BD=AC=60,53, is to the Depth of the Tun, viz. RS=60, so is $fD=20,14$, to $f, q=19,96$. Now to find the Area of the Part DC f , you must consult the second Rule before-going, which was given to find the Part Bg o B; Thus,

The Squ. of the bot. Diameter, viz. DC=106 is 11236
Half the Pro. of the Di. CD=106 in $wf=100,68$ is, 5336,04

Their Sum is 16572,04
Which multiply'd by the Depth $f q = 19,96$

Produceth 330777,9184
Which Product divide by 1077, and }
the Quotient will be the Content of } viz. 307,1289
DC f in Ale Gallons,

But if you would find the Content of the other Parts, viz. C $f w$, you may consult the first Rule which was given to find the Part ABg A, as below.

To find the Content of the upper Part of this Fruustum, viz. C $f w$.

The Square of the top Diam. $wf = 100,68$ is 10136,4624
 Half the Product of the Diam. $wt = 100,68$ } 5336,04
 into $CD = 106$ is

Their Sum is 15472,5024
 Which multiply by the Depth $f q = 19,96$ 19,96

928350144
 1392525216
 1392525216
 154725024

And the Product is 308831,147904
 Which divide by 1077, and the Quo- }
 tient will be the Content of the Part } *i. e.* 286,7516
Cf w in Ale Gallons.

I have insisted upon this Matter, more than I would have done, had I not been importuned so to do, by some Gentlemen, whose Curiosity was such, that they would find all, or as much as possible could be found, by Calculation; and because 'tis what I never did see in any other Author, I thence concluded, that I might oblige others in so doing, as well as my Friends. And though some may think what is here done by Calculation, might have been found by extending Lines, and measuring more Distances than from *A* to *g*, with more Ease, &c. yet if the Line *Ag* be truly taken, and also the top and bottom Diameters, with the Depth of the Tun; what else is to be found, may be had this Way, with more Ease and Exactness than any other; nay, and looks more like Art; for what would a Man (who is ignorant in Mathematical Learning) think, if he should see an Officer pour Liquor by a known Measure into the Tun, till he had covered the Bottom? He would know it was but a Shift. And to use a Mason's Level, Compasses, &c. is altogether as mechanical.

How

The General Gauger.

How the Divisors, hitherto made use of, may be found, by knowing what Proportion their respective Figure has to its circumscribing Cylinder or Parallelopipedon.

A Cylinder is $\frac{177,5}{226}$ of the Parallelopipedon that circumscribes it, and 282 and 231 are the Number of Inches contained in an Ale or Wine Gallon, according to the Statute, and the proper Divisors for a Parallelopipedon; I demand the Divisors for a Cylinder.

Say, as 177,5 the Numerator, is to 226 the Denominator; so is the Divisor for a Parallelopipedon, to the Ale Divisor for a Cylinder.

$$\text{As } 177,5 : 226 :: 6282$$

226

1692

564

564

177,5)	63732,0000	(359,053 Ale Divi-
	104875055	for for a Cylin.
	1609522	
	00969.	
	00	

For

For the Beer Divisor.

$$\text{As } 1 : 3 :: 359,053 :$$

1077,159 The Beer Divisor for a Cone.

For the Malt Divisor.

$$\text{As } 1 : 3 :: 2737,99 : 8213,07 \text{ But you may use}$$

$$3 \quad 8212,41 \text{ (if an Officer.)}$$

$$8213,97$$

I shall insist no farther in these Examples, because what is said of the Cone is sufficient to inform the meanest Capacity how to proceed in the Globe, Spheroid, Square, Pyramid, parabolick Conoid, hyperbolick Conoid, and parabolick Spindle, when he knows what Part of their circumscribing Cylinder they are; and when that is known, the Proportion will be as the Numerator is to the Denominator, so is the Beer, Wine, and Malt Divisors of a Cylinder, to the like Divisors for that Figure.

A Cylinder is $\frac{1}{4}$ of the Parallelopipedon that circumscribes it, or (nearer) $\frac{177,5}{226}$ of it as above.

A Cone is $\frac{1}{3}$ of its circumscribing Cylinder.

A Globe is $\frac{2}{3}$ of the Cylinder that circumscribes it, having equal Diameters and Heighth.

A Spheroid is $\frac{2}{3}$ of the Cylinder, whose Conjugate is the Diameter, and transverse Diameter the Depth of the Cylinder.

As a Cone is $\frac{1}{3}$ of a Cylinder, so a square Pyramid is $\frac{1}{3}$ of that Parallelopipedon that circumscribes it, having the same Base and Altitude; and in general, let the Base of a Pyramid be what you please, *i. e.* square, circular, triangular, polygonal,

polygonal, &c. they will be but $\frac{1}{3}$ of their circumscribing Prisms, that have the same Base and Heighth.

A parabolick Conoid is $\frac{1}{2}$ of the Cylinder that circumscribes it, supposing it to have the same Base and Altitude with that of the Cylinder.

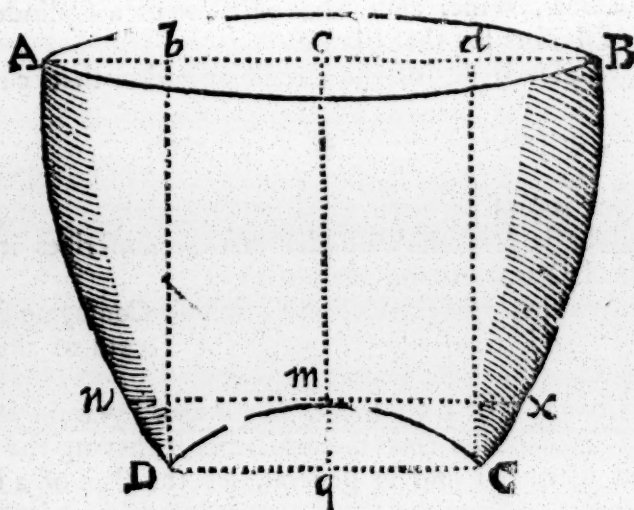
A hyperbolick Conoid is $\frac{2}{3}$ of the Cylinder that circumscribes it, having the same Base and Altitude as the Cylinder.

A parabolick Spindle is $\frac{8}{15}$ of that Cylinder, whose Axis is the same with the parabolick Spindle, and Diameters equal.

He that would know more of the Nature of theſe Figures, may have Recourſe to that ingenious Piece of Work done by Mr. *Haves*, Entitled, *Mathematical Philoſophy*, where from Page 161 to Page 177, they may be fully ſatisfied.

To gauge a Copper, and make Allowance for the Crown.

Let ABCD represent a Copper to be gauged, the Dimensions may be taken, and the Content found, as below.



I. First

1. First fasten a small Chord or Thread at A, and extend the other End diametrically to the Point B, where fasten it also; then set one End of your Instrument on D, and move the upper End thereof toward A or c, till you find the nearest Distance of the Point D, to the Thread AB, which will be when moved to b ; let bD be 40 Inches, the Depth of the Furnace or Copper.

2. In like manner set one End of your Instrument upon the Top of the Crown at m , and take the nearest Distance of that Point to the Line AB, which let be $cm = 30$ Inches; which take from $Db = Cd = 40$, and there will remain the Depth or Height $mq = 10$ Inches.

To find the Diameter of the Crown DC, measure AB, and call it 126 Inches.

Then take a Thread and Plummets, and setting one End thereof upon the Line AB, draw it along that Line from A towards B, until the Plummets hangs just over the Point D, which it will do when at b ; then measure Ab and suppose it to be 12,3 Inches; then find the Distance Bd , and let that be 12,3 Inches also: Add these together, and their Sum is 24,6, which take from the Diameter at the Top, viz. $AB = 126$, and there will remain the Diameter of the Crown $DC = 101,4$ Inches.

Now to find the Content of the Copper from the Crown upwards, (that is, the Part AB wx), the Depth (mc) being 30 Inches, you may find a Diameter in the Middle of every 5 Inches of the Depth mc ; which having found, you may set them against their respective Depths, as in the second Column of the following Table: Then find (by the Ale Gauge-point upon the Sliding Rule) the Areas of those several Diameters, and set them against their proper Diameters in the third Column: Having so done, the fourth Column is made by multiplying each Area by 5, so have you the Content of the Part AB wx , at every 5 Inches

Inches of the Depth mc , which added together makes
 B. F. Gall.

32 : 00 : 3,3.

Parts of the Depth	Dia- meters.	The A- reas of those Diam.	Content of every Inches reduced to. B. F. Gall.
5	124,8	43,38	6 : 01 : 4,4
5	119,9	40,04	5 : 03 : 4,7
5	115,7	37,3	5 : 01 : 8,0
5	111,3	34,5	5 : 00 : 2,5
5	108,8	32,97	4 : 03 : 3,4
5	103,9	20,06	4 : 01 : 5,8
30	Sum is		32 : 00 : 3,3
To cover the Crown			4 : 03 : 5,8
Content of the Copper			36 : 03 : 9,1

For the Content of the Part $w x$ DC.

The Diameter $w x$ is 110,6, and DC = 101,4, and the Depth mg is 10.

The Area of the top Diam. viz. $w x = 110,6$ is 34,0734

The Area of the bottom Diam. viz. DC = 101,4 28,64

A Geometrical Mean by the Sliding is 31,24

Which multiply'd by the Depth $mg = 10,$

The Pro. will be the Content required, viz. 312,40 Gall.

For the Content of the Part D m C q D.

If we suppose this Part to be the Frustum of a Globe;
 its Diameter DC being 101,4 Inches, and Altitude $mq = 10.$
 The

The Content (by the Rule herein before given for this Purpose) will be found to be 145,0565 Gallons.

Now if we subtract the Content of the Crown (D in C of D) last found, viz. 145,0565 from the Content of the Parts vx DC , viz. 312,4, there will remain 167,3435 Gallons, and so much Liquor the Crown will take to cover it; which is 4 Bar. 3 Fir. 5,8 Gall. Add this to the

B. F. Gall.

Part AB vx , viz. 32 : 00 : 3,3, and the Sum will be the Content of the Furnace or Copper AD in CB , viz. B. F. Gall.

36 : 03 : 9,1, which was required, and the same may be done in any other the like Case. And note, that the more curved the Sides of any Figure is, the more mean Circles you ought to take, i. e. in the Middle of every 8, 6, or 4 Inches, &c.

Having the Diameters and Depth of any conical Tun, to find the Diameter at any Depth at one Operation.

R U L E.

Say, as the Depth of the Tun is to half the Difference of the bottom and top Diameters, so is any Depth to half the Difference between the bottom Diameter, and that at the Depth proposed; which doubled and added to the bottom Diameter, the Sum will be the Diameter required.

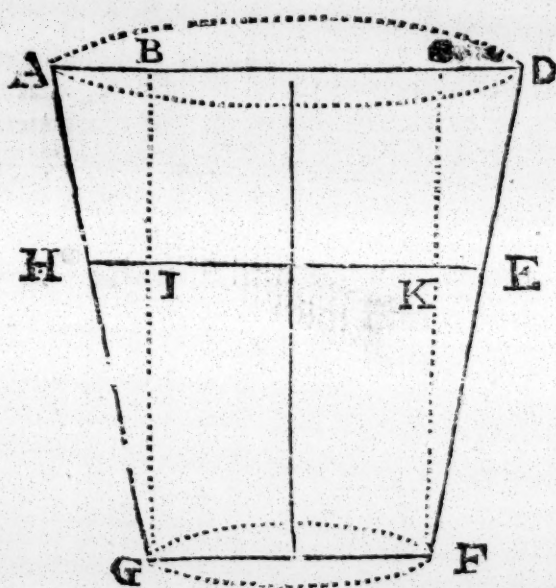
E X A M P L E I.

Let $ABCDEFGH$ represent a Tun in the Form of the Frustum of a Cone standing on its lesser Base; let the Diameter AD be 50 Inches, the Diameter GF 40 Inches, and the Depth BG or CF 20, and the given Depth KF or $IG=14$ Inches to find the Diameter HE .

S

The

The Triangles CFD , and KFE being Similar, the Proportion will be as before, *i. e.* as the Depth of the Tun $CF=20$, is to DC half the Difference of AD , and $FG=5$; so is $KF=14$, to KE half the Difference of GF and HE , *viz.* $3,5$, which doubled is 7 , and this added to the bottom Diameter GF , gives 47 for the Diameter HE required; and the like may be done for the Diameter at any other Depth, when the Tun stands upon its lesser Base.

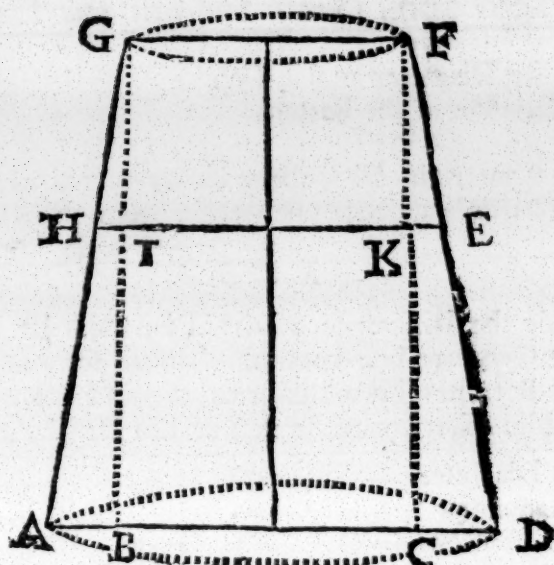


EXAMPLE II.

Let a Tun having the same Dimensions, be given only in another Position, *i. e.* standing upon its greater Base; and it be required to find the Diameter at 14 Inches from the Bottom, as above.

I demand the said Diameter.

R U L E



R U L E.

Say, as the Depth $FC = 20$ Inches, is to Half the Difference of the Diameters GF and AD , *i. e.* $CD = 5$, so is $FK = 6$, (*i. e.* the Distance from the Top to the Diameter HE required) to $KE = 1,5$, which doubled is 3, and this added to $40 = GF$, is 43 for the Diameter HE sought; and the same way of working must be observed to find the Diameter at any other Depth, when the Tun is in this Position. Where note, that in either of these Figures we may suppose the Line HE to be the Diameter of the Liquor's Surface, which, with the Depth 14 and bottom Diameter, the true Quantity of Liquor may be found which is now in the Tun, or which it will hold at 14 Inches-deep.

To find how many Gallons a conical Tun will hold upon every Inch of the Depth.

Let the Diameter at the Top be	18 Inches.
The Diameter at the Bottom	98
Depth	40

The Content, in Ale Gallons is 885,5, how many Ale Gallons will this Tun hold upon every Inch of its Depth?

R U L E.

Divide the Difference of the Diameters by the Depth, and the Quotient is a common Addend for one Inch from Top to Bottom; by which you may find the Diameter in the Middle of every 10 Inches of the Depth, as below.

Bottom Diameter	98	
Top Diameter	80	
Their Difference	18	for a Dividend, which
divide by 40)	18,00	(,45 the Addend for one Inch.
	20)0	
	0	

Now 5, 15, 25 and 35, are the Inches which fall in the Middle of every 10 Inches of the Depth, which Depths, if you multiply by the common Addend, will shew what must be added to the top Diameter, to find the Diameters at those Depths. Thus,

5,	15,	25,	35,
,45	,45	,45	,45
2,25	6,75	11,25	15,75
80, Top Diameter			
2,25			
82,25 Diam. at 5 Inch. deep, its Area	18,84	= 00 : 2 : 1,84	
			80, Top

80, Top Diameter

6,75

Gall. Bar. F. Gall.

86,75 Diam. at 15 Inch. deep, its Area 20,96=00 : 2 : 3,96

80, Top Diameter

11,25

91,25 Diam. at 25 Inch. deep, its Area 23,19=00 : 2 : 6,19

80, Top Diameter

15,75

95,75 Diam. at 35 Inch. deep, its Area 25,53=00 : 3 : 0,03

The Sum of the Areas are

88,52 which multi-

plied by 10, is 885,2, the Tun's Content.

Bar. Fir. Gall.

Now 18,84 Gallons, or 00 : 02 : 1,84 being an Area common to any of the first ten Inches; you are to subtract either of them from the Tun's Content in the like Name continually, and the Remainder will be the Area at each of the first ten Inches; and then for the next ten

Bar. Fir. Gall.

Inches you must take 20,96 or 00 : 02 : 3,96 out of the last Remainder, &c. as in the following Table.

Bar. Fir. Gall. Pts.

The whole Content is 885,2 Gallons, or 26 : 00 : 1,20

02 : 1,84

25 : 01 : 7,86

02 : 1,84

24 : 03 : 6,02

02 : 1,84

24 : 01 : 4,18

Bar. Fir. Gall. Pts.

24 : 01 : 4,18

02 : 1,84

23 : 03 : 2,34

02 : 1,84

23 : 01 : 0,50

02 : 1,84

22 : 02 : 7,16

02 : 1,84

22 : 00 : 5,32

02 : 1,84

21 : 02 : 3,48

02 : 1,84

21 : 00 : 1,64

02 : 1,84

20 : 01 : 8,30

02 : 3,96

19 : 03 : 4,34

02 : 3,96

19 : 01 : 0,38

02 : 3,96

18 : 2 : 4,92

2 : 3,96

18 : 0 : 0,96

2 : 3,96

17 : 1 : 5,50

2 : 3,96

16 : 3 : 1,54

2 : 3,96

16 : 0 : 6,08

2 : 3,96

15 : 2 : 2,12

Note,

The General Gauger.

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Bar. Fir. Gall. Pts.

15 : 2 : 2,12
2 : 3,96

14 : 3 : 6,66
2 : 3,96

Note,

14 : 1 : 2,70
2 : 6,19

13 : 2 : 5,01
2 : 6,19

12 : 3 : 7,32
2 : 6,19

12 : 1 : 1,13
2 : 6,19

11 : 2 : 3,44
2 : 6,19

10 : 3 : 5,75
2 : 6,19

10 : 0 : 8,06
2 : 6,19

9 : 2 : 1,87
2 : 6,19

8 : 3 : 4,18
2 : 6,19

Note,

8 : 0 : 6,49
2 : 6,19

7 : 2 : 0,30
3 : 0,03

6 : 5 : 0,27

Bar. Fir. Gall. Pts.

6	:	3	:	0,27
		3	:	0,03

6	:	0	:	0,24
		3	:	0,03

5	:	1	:	0,21
		3	:	0,03

4	:	2	:	0,18
		3	:	0,03

3	:	3	:	0,15
		3	:	0,03

3	:	0	:	0,12
		3	:	0,03

2	:	1	:	0,09
		3	:	0,03

1	:	2	:	0,06
		3	:	0,03

0	:	3	:	0,03
		3	:	0,03

0	:	0	:	0,00
---	---	---	---	------

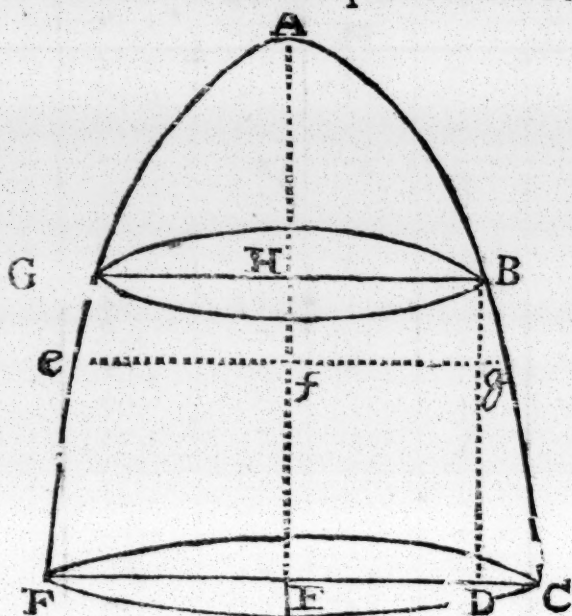
The Table following is collected from the preceding Work, whose Use is to find how much Liquor is in such a Tun, by having the Distance of the Liquor's Surface from the Top: Thus, let it be 20 Inches, look 20 in the first

Bar. Fir. Gall. Pts.

Column, and against it you'll find 14 : 01 : 2,70, *i. e.* 14 Barrels, 1 Firkin, 2 Gallons, and seven tenth Parts, and so for any other Frustum of a Pyramid. Inches.

Inches.	Barrels.	Firkins.	Gall. Pts.
0	26	00	1,20
1	25	01	7,86
2	24	03	6,02
3	24	01	4,18
4	23	03	2,34
5	23	01	0,50
6	22	02	7,16
7	22	00	5,32
8	21	02	3,48
9	21	00	1,64
10	20	01	8,30
11	19	03	4,34
12	19	01	0,38
13	18	02	4,92
14	18	00	0,96
15	17	01	5,50
16	16	03	1,54
17	16	00	6,08
18	15	02	2,12
19	14	03	6,66
20	14	01	2,70
21	13	02	5,01
22	12	03	7,32
23	12	01	1,13
24	11	02	3,44
25	10	03	5,75
26	10	00	8,06
27	9	02	1,87
28	8	03	4,18
29	8	00	6,49
30	7	02	0,30
31	6	03	0,27
32	6	00	0,24
33	5	01	0,21
34	4	02	0,18
35	3	03	0,15
36	3	00	0,12
37	2	01	0,09
38	1	02	0,06
39	0	03	0,03
40	0	00	0,00

To find the Diameter at any Depth of a Tun, in the Form of the Frustrum of a parabolick Conoid.



DEFINITIONS.

If we conceive the curve Line FGABC to represent a Parabola ; then,

HB is called a Semiordinate, and AH its Abfcissa ; and so EC is a Semiordinate, and AE its Abfcissa.

The Latus-Rectum of a Parabola (as of this) is such a Line, as that being multiplied by the Abfcissa AH, the Rectangle or Product will be equal to the Square of HB.

If you multiply it by the Abfcissa AE, then the Rectangle will be equal to the Square of EC, and will always be so, as in *Apoll. Prop. 11. Lib. 1.*

Now to find the Latus-Rectum of the Parabola by having only the top Diameter $GB = 40$, the bottom Diameter $FC = 50$, and the Depth HE or BD $= 20$, must be performed by that Property of the Parabola, commonly called *Baker's*

ker's Property, whereon his *Clavis Geometrica Catholica* depends, and is this.

In the Parabola, the Latus-Rectum is to the Sum of any two Semiordinates, as their Difference is to the Difference of their Abscissa; that is in this present Case, as L (the Latus-Rectum) is to $HB + EC = FD$, so is DC to BD: And by changing the Consequents to Antecedents, the Proportion will stand thus:

As $BD : DC :: FD : L$, that is, in Words, as the Depth of the Tun (BD) 20 is to half the Difference of the Diameters $DC = 5$, so is half the Sum of the Diameters (GB and FC) 45 to 11,25, and so much is the Latus-Rectum of the Parabola belonging to the Figure.

Having thus found the Parameter or Latus-Rectum, we are next to find the Length of the Line AH, the proper Abscissa to the Semiordinate HB; to do which, you are to know, that the Square of HB is equal to the Rectangle of the Latus-Rectum and Abscissa AH. Therefore divide the Square of $HB = 400$, by the Latus-Rectum 11,25, and the Quotient will be 35,55555 of the Abscissa AH; to which add $6 = Hf$, and the Sum is $Af = 41,55555$, or the proper Abscissa of the Semiordinate fg , which is now only wanting. But knowing its Square is equal to the Rectangle of the Latus-Rectum and Abscissa Af , multiply 41,55555 by 11,25, and the Product is ——— 467,4999375, which is the Square of the Semiordinate fg ; the Square Root of which is 21,6217, which doubled is 43,2434, the Diameter eg required; and so of any other. This will not appear difficult to any who understand so much of the Conick Sections as is requisite for the Construction of Algebraick Equations.

Many Things of this Nature I might insist upon, as in showing how to find the Diameters at every Inch of this Depth, of this, or any other regular Tun: But what has been said already, may be sufficient to excite the industrious Reader to peruse others who have taken more Room in Writing to that Purpose, than I have Time to do at present. But if what is here done proves any way serviceable, I have my Desire; and by knowing it to be approved of, shall be encouraged thereby to publish some things in the Art of Gauging, as may oblige Posterity.

A

A T A B L E of *Circles, Areas*, in Malt Bushels and decimillesimal Parts, calculated to every tenth Part of an Inch of the Diameter from 12 to 100 Inches.

D.	0	1	2	3	4
12	0,0526	0,0534	0,0543	0,0552	0,0561
13	0,0617	0,0626	0,0636	0,0646	0,0656
14	0,0716	0,0726	0,0736	0,0747	0,0757
15	0,0822	0,0833	0,0844	0,0855	0,0866
16	0,0935	0,0946	0,0957	0,0970	0,0982
17	0,1055	0,1068	0,1080	0,1093	0,1106
18	0,1183	0,1196	0,1210	0,1223	0,1236
19	0,1318	0,1332	0,1346	0,1360	0,1374
20	0,1461	0,1475	0,1490	0,1505	0,1520
21	0,1611	0,1626	0,1642	0,1657	0,1670
22	0,1768	0,1784	0,1800	0,1816	0,1833
23	0,1932	0,1949	0,1966	0,1983	0,2000
24	0,2104	0,2121	0,2139	0,2157	0,2174
25	0,2283	0,2301	0,2319	0,2338	0,2356
26	0,2469	0,2488	0,2507	0,2526	0,2546
27	0,2663	0,2682	0,2702	0,2725	0,2758
28	0,2864	0,2884	0,2904	0,2925	0,2946
29	0,3072	0,3093	0,3114	0,3136	0,3151
30	0,3287	0,3309	0,3331	0,3353	0,3376
31	0,3512	0,3516	0,3556	0,3578	0,3601
32	0,3740	0,3764	0,3787	0,3810	0,3834
33	0,3978	0,4002	0,4026	0,4050	0,4075
34	0,4222	0,4247	0,4272	0,4297	0,4322
35	0,4475	0,4500	0,4526	0,4552	0,4577
36	0,4735	0,4760	0,4787	0,4813	0,4840
37	0,5001	0,5028	0,5055	0,5082	0,5109
38	0,5275	0,5302	0,5330	0,5358	0,5386
39	0,5556	0,5684	0,5613	0,5642	0,5670

5	6	7	8	9
0,0570	0,0579	0,0589	0,0598	0,0607
0,0657	0,0675	0,0685	0,0695	0,0705
0,0768	0,0778	0,0792	0,0800	0,0811
0,0877	0,0888	0,0900	0,0912	0,0923
0,0994	0,1006	0,1018	0,1031	0,1042
0,1118	0,1131	0,1144	0,1157	0,1170
0,1250	0,1263	0,1277	0,1291	0,1304
0,1389	0,1403	0,1417	0,1432	0,1446
0,1535	0,1550	0,1565	0,1580	0,1595
0,1688	0,1704	0,1720	0,1736	0,1752
0,1850	0,1866	0,1882	0,1899	0,1915
0,2017	0,2034	0,2052	0,2070	0,2086
0,2192	0,2210	0,2228	0,2246	0,2264
0,2375	0,2394	0,2412	0,2431	0,2450
0,2565	0,2584	0,2604	0,2623	0,2643
0,2762	0,2782	0,2803	0,2823	0,2843
0,2968	0,2988	0,3009	0,3029	0,3151
0,3178	0,3200	0,3215	0,3244	0,3265
0,3398	0,3420	0,3443	0,3465	0,3488
0,3624	0,3647	0,3670	0,3694	0,3717
0,3858	0,3882	0,3906	0,3930	0,3954
0,4099	0,4124	0,4148	0,4173	0,4198
0,4348	0,4373	0,4398	0,4424	0,4449
0,4603	0,4629	0,4655	0,4681	0,4708
0,4866	0,4893	0,4920	0,4947	0,4974
0,5137	0,5164	0,5192	0,5219	0,5247
0,5414	0,5442	0,5471	0,5499	0,5527
0,5699	0,5728	0,5757	0,5786	0,5815

T

Areas

Areas of Circles in Malt Bushels.

D.	0	1	2	3	4
40	0,5844	0,5874	0,5903	0,5932	0,5962
41	0,6140	0,6170	0,6200	0,6230	0,6261
42	0,6444	0,6474	0,6505	0,6536	0,6567
43	0,6754	0,6786	0,6817	0,6849	0,6880
44	0,7072	0,7104	0,7136	0,7169	0,7201
45	0,7397	0,7430	0,7463	0,7496	0,7529
46	0,7729	0,7763	0,7797	0,7831	0,7864
47	0,8069	0,8104	0,8138	0,8173	0,8207
48	0,8416	0,8451	0,8486	0,8522	0,8557
49	0,8770	0,8826	0,8842	0,8878	0,8914
50	0,9132	0,9169	0,9206	0,9242	0,9279
51	0,9501	0,9538	0,9576	0,9613	0,9650
52	0,9877	0,9915	0,9954	0,9992	1,0030
53	1,0261	1,0300	1,0338	1,0377	1,0416
54	1,0652	1,0691	1,0731	1,0770	1,0810
55	1,1050	1,1090	1,1130	1,1171	1,1211
56	1,1455	1,1496	1,1537	1,1579	1,1620
57	1,1868	1,1910	1,1952	1,1993	1,2035
58	1,2288	1,2331	1,2373	1,2416	1,2458
59	1,2716	1,2759	1,2802	1,2845	1,2889
60	1,3150	1,3194	1,3238	1,3282	1,3326
61	1,3593	1,3637	1,3680	1,3726	1,3771
62	1,4042	1,4087	1,4133	1,4178	1,4224
63	1,4498	1,4544	1,4591	1,4637	1,4683
64	1,4962	1,5009	1,5056	1,5103	1,5150
65	1,5434	1,5581	1,5529	1,5576	1,5624
66	1,5912	1,5960	1,6009	1,6057	1,6100
67	1,6398	1,6447	1,6496	1,6545	1,6594
68	1,6891	1,6941	1,6991	1,7040	1,7090
69	1,7392	1,7442	1,7493	1,7543	1,7594
70	1,7899	1,7951	1,8002	1,8053	1,8104
71	1,8414	1,8466	1,8518	1,8570	1,8622

5	6	7	8	9
0,5991	0,6021	0,6050	0,6081	0,6110
0,6291	0,6321	0,6352	0,6382	0,6444
0,6598	0,6629	0,6660	0,6691	0,6723
0,6912	0,6944	0,6976	0,6978	0,7040
0,7233	0,7266	0,7299	0,7331	0,7364
0,7572	0,7596	0,7629	0,7662	0,7696
0,7898	0,7932	0,7966	0,8001	0,8035
0,8242	0,8277	0,8311	0,8346	0,8381
0,8592	0,8628	0,8664	0,8699	0,8735
0,8950	0,8987	0,9023	0,9059	0,9096
0,9316	0,9353	0,9390	0,9427	0,9464
0,9688	0,9726	0,9764	0,9802	0,9839
1,0008	1,0110	1,0145	1,0184	1,0222
1,0455	1,0495	1,0534	1,0573	1,0612
1,0850	1,0890	1,0935	1,0970	1,1010
1,1252	1,1292	1,1333	1,1374	1,1415
1,1611	1,1702	1,1744	1,1785	1,1827
1,2077	1,2119	1,2162	1,2204	1,2246
1,2501	1,2544	1,2587	1,2630	1,2673
1,2934	1,2976	1,3019	1,3063	1,3107
1,3371	1,3415	1,3459	1,3503	1,3548
1,3816	1,3860	1,3906	1,3951	1,3997
1,4269	1,4315	1,4361	1,4406	1,4452
1,4729	1,4776	1,4822	1,4868	1,4916
1,5190	1,5244	1,5292	1,5339	1,5386
1,5672	1,5720	1,5768	1,5816	1,5864
1,6154	1,6203	1,6252	1,6300	1,6349
1,6644	1,6693	1,6742	1,6792	1,6841
1,7140	1,7191	1,7241	1,7291	1,7341
1,7645	1,7695	1,7746	1,7797	1,7848
1,8156	1,8208	1,8259	1,8311	1,8363
1,8675	1,8727	1,8779	1,8831	1,8884

T 2

Areas

208 Areas in Circles in Malt Bushels.

D.	0	1	2	3	4
72	1,8937	1,8989	1,9043	1,9095	1,9148
73	1,9466	1,9522	1,9573	1,9627	1,9680
74	2,0003	2,0058	2,0112	2,0166	2,0220
75	2,0548	2,0603	2,0658	2,0712	2,0768
76	2,1099	2,1155	2,1211	2,1266	2,1322
77	2,1658	2,1715	2,1771	2,1827	2,1884
78	2,2225	2,2282	2,2339	2,2396	2,2453
79	2,2798	2,2856	2,2914	2,2972	2,3029
80	2,3379	2,3437	2,3496	2,3555	2,3612
81	2,3967	2,4026	2,4085	2,4145	2,4204
82	2,4562	2,4622	2,4682	2,4742	2,4830
83	2,5165	2,5226	2,5287	2,5347	2,5408
84	2,5775	2,5837	2,5898	2,5960	2,6021
85	2,6393	2,6455	2,6517	2,6579	2,6642
86	2,7017	2,7080	2,7143	2,7206	2,7269
87	2,7649	2,7713	2,7776	2,7840	2,7904
88	2,8283	2,8353	2,8417	2,8489	2,8549
89	2,8935	2,9000	2,9065	2,9131	2,9196
90	2,9589	2,9655	2,9721	2,9787	2,9853
91	3,0250	3,0327	3,0383	3,0450	3,0517
92	3,0919	3,0986	3,1053	3,1121	3,1188
93	3,1595	3,1694	3,1739	3,1799	3,1867
94	3,2278	3,2346	3,2415	3,2484	3,2553
95	3,2968	3,3078	3,3107	3,3177	3,3246
96	3,3666	3,3736	3,3806	3,3877	3,3947
97	3,4371	3,4442	3,4513	3,4584	3,4655
98	3,5083	3,5155	3,5226	3,5297	3,5330
99	3,5803	3,5874	3,5948	3,6020	3,6093
100	3,6530	3,6603	3,6676	3,6749	3,6823

5	6	7	8	9
1,9201	1,9254	1,9307	1,9360	1,9413
1,9734	1,9788	1,9342	1,9895	1,9949
2,0275	2,0329	2,0384	2,0438	2,0492
2,0822	2,0878	2,0922	2,0988	2,1041
2,1378	2,1434	2,1490	2,1546	2,1602
2,1940	2,1997	2,2057	2,2111	2,2168
2,2510	2,2568	2,2625	2,2682	2,2740
2,3088	2,3146	2,3204	2,3262	2,3320
2,3672	2,3731	2,3790	2,3849	2,3908
2,4264	2,4323	2,4382	2,4443	2,4502
2,4863	2,4923	2,4984	2,5044	2,5105
2,5469	2,5530	2,5591	2,5653	2,5714
2,6033	2,6145	2,6207	2,6269	2,6331
2,6704	2,6767	2,6829	2,6892	2,6945
2,7332	2,7396	2,7459	2,7522	2,7586
2,7968	2,8032	2,8096	2,8160	2,8224
2,8611	2,8676	2,8740	2,8805	2,8870
2,9261	2,9326	2,9392	2,9458	2,9523
2,9919	2,9985	3,0051	3,0117	3,0184
3,0583	3,0650	3,0717	3,0784	3,0852
3,1256	3,1323	3,1391	3,1459	3,1527
3,1935	3,2004	3,2072	3,2140	3,2209
3,2622	3,2691	3,2760	3,2820	3,2899
3,3316	3,3386	3,3456	3,3526	3,3596
3,4017	3,4088	3,4158	3,4229	3,4300
3,4726	3,4797	3,4869	3,4939	3,5012
3,5442	3,5514	3,5586	3,5658	3,5731
3,6165	3,6238	3,6311	3,6384	3,6457
3,6896	3,6969	3,7043	3,7117	3,7180

The

The Description and Use of the preceding Table.

In this Table are eleven Columns; in the first you have the Diameter of any Circle from 12 to 100 Inches, and in the second stands the Area of that Circle.

E X A M P L E I.

Let it be required to find the Area in Malt Bushels of that Circle, whose Diameter is 36 Inches.

Find 36 in the first Column, and against that in the second Column, you'll find 0,4734, which signifies that the Cylinder whose Diameter is 36 Inches, will hold but ,4734 of a Bushel of Malt upon an Inch.

E X A M P L E II.

Let it be required to find the Area of that Circle, whose Diameter is 97 Inches.

Find 97 in the first Column, and against that in the second you'll find 3,4371; the Area required.

E X A M P L E III.

What's the Area of that Circle, whose Diameter is 150 Inches?

Find 15 in the first Column, and against that in the second you'll find 0,0822, which is the Area of that Circle, whose Diameter is 15; but if you move the Comma two Places towards the Right-hand, 'twill be 008,22, *i. e.* 8,22; the Area required.

E X A M P L E IV.

What's the Area of that Circle, whose Diameter is 42,6?

Find 42 Inches in the first Column, and ,6 at the Top; and in the Angle of Meeting you'll find 0,6629; the Area required.

E X A M P L E V.

What's the Area of that Circle, whose Diameter is 148?

Find 14 in the first Column, and ,8 at the Top; then in the Angle of Meeting you'll find 0,0800; but setting the Point two Places back, 'twill be 008,00, *i. e.* 8,00; the Area required.

E X

E X A M P L E VI.

What's the Area of that Circle, whose Diameter is 148,5?

Find by the last Example, the Area of 149; which is 8,11, their Difference is ,11, and Half their Difference is ,055; which added to 8,00 is 8,055; the Area of 148,5 required.

E X A M P L E VII.

What's the Area of that Circle, whose Diameter is 123,3?

1. Find the Area of 123, which is 5,52

2. Find the Area of 124, which is 5,61

their Difference is ,09; which multiplied by 3, gives 027 and that added to 5,52, makes 5,547; the Area required.

E X A M P L E VIII.

What's the Area of that Circle, whose Diameter is 123,8?

1. Find the Area of 123, and that is 5,52

2. Find the Area of 124, and that is 5,61

their Difference is 0,09
which multiplied by 8, produceth ,072; and this added to 5,52 gives 5,592; the Area required.

By these eight Examples, it may sufficiently appear, that the Area of any Circle from 12 to 100 Inches Diameter, may be found by Inspection; and that the Area of any Circle from 12 to 1000 Inches Diameter, may by the same Tables be found near enough in Practice.

A T A B L E to gauge right-lined Figures; as Squares, Triangles, Trapezia's, &c. giving the Content of the Squares from 21 to 120 Inches in Breadth, and from 30 to 310 in Length, by Inspection; and consequently of any other Length and Breadth, by Addition.

20	21	22	23	24	25
30	,2930	,3069	,3209	,3349	,3488
40	,3907	,4093	,4279	,4465	,4651
50	,4884	,5116	,5448	,5581	,5813
60	,5860	,6139	,6418	,6647	,6977
70	,6837	,7162	,7488	,7813	,8139
80	,7814	,8186	,8558	,8913	,9302
90	,8790	,9209	,9627	,1,0046	,1,0465
100	,9767	,1,0232	,1,0697	,1,1162	,1,1628
110	,1,0744	,1,1256	,1,1567	,1,2279	,1,2790
120	,1,1720	,1,2279	,1,2837	,1,3395	,1,3953
130	,1,2697	,1,3302	,1,3967	,1,4511	,1,5110
140	,1,3674	,1,4325	,1,4976	,1,5628	,1,9279
150	,1,4651	,1,5349	,1,6046	,1,6744	,1,7442
160	,1,5628	,1,6372	,1,7116	,1,7860	,1,8604
170	,1,6004	,1,7395	,1,8186	,1,8970	,1,9767
180	,1,7580	,1,8418	,1,9255	,2,0093	,2,0930
190	,1,8557	,1,9422	,2,0325	,2,1209	,2,2093
200	,1,9534	,2,0465	,2,1395	,2,2325	,2,3256
210	,2,0511	,2,1488	,2,2465	,2,3442	,2,4418
220	,2,1488	,2,2511	,2,3534	,2,4558	,2,5581
230	,2,2465	,2,4535	,2,4604	,2,5674	,2,6744
240	,2,3442	,2,5558	,2,5674	,2,6790	,2,7907
250	,2,4418	,2,5581	,2,6744	,2,7906	,2,9069
260	,2,5395	,2,6604	,2,7831	,2,9023	,3,0232
270	,2,6372	,2,7628	,2,8883	,3,0139	,3,1395
280	,2,7348	,2,8651	,2,9953	,3,1256	,3,2558
290	,2,8325	,2,9674	,3,1023	,3,2372	,3,3572
300	,2,9302	,2,0697	,3,2093	,3,3488	,3,4883
1	,0,097	,0,102	,0,107	,0,111	,0,116
2	,0,195	,0,204	,0,214	,0,223	,0,232
3	,0,293	,0,307	,0,321	,0,335	,0,348
4	,0,390	,0,390	,0,428	,0,446	,0,465
5	,0,488	,0,488	,0,535	,0,558	,0,581
6	,0,586	,0,586	,0,642	,0,664	,0,697
7	,0,683	,0,683	,0,749	,0,781	,0,813
8	,0,781	,0,781	,0,856	,0,893	,0,930
9	,0,879	,0,879	,0,963	,1,004	,1,046

26	27	28	29	30
,3626	,3767	,3907	,4046	,4186
,4836	,5023	,5209	,5395	,5581
,6046	,6279	,6511	,6744	,6976
,7256	,7535	,7814	,8093	,8372
,8465	,8590	,9116	,9441	,9767
,9674	1,0046	1,0420	1,0790	1,1162
1,0883	1,1302	1,1721	1,2139	1,2558
1,2093	1,2558	1,3023	1,3488	1,3953
1,3302	1,3814	1,4325	1,4837	1,5349
1,4511	1,5069	1,5628	1,6186	1,6744
1,5721	1,6325	1,6930	1,7534	1,8139
1,6930	2,7581	1,8232	1,8884	1,9535
1,8139	2,8837	1,9534	2,0235	2,0930
1,9349	2,0090	2,0837	2,1581	2,2325
2,0358	2,1348	2,2139	2,2930	2,3721
2,1766	2,2604	2,3441	2,4279	2,5116
2,2976	2,3860	2,4744	2,5628	2,6511
2,4186	2,5116	2,6046	2,6976	2,7906
2,5395	2,6372	2,5348	2,8325	2,9302
2,6604	2,7628	2,8651	2,9674	3,0697
2,7814	2,8884	2,9953	3,1023	3,2093
2,9023	3,0139	2,1256	3,2372	3,3488
3,0232	3,1395	2,2558	3,3721	3,4883
3,1442	3,2651	3,3860	3,5069	3,6279
3,2651	3,3907	3,5163	3,6418	3,7674
3,3860	3,5163	3,6465	3,7767	3,9069
3,5069	3,6418	3,7767	3,9116	4,0465
3,6279	3,7674	3,9069	4,0465	4,1860
,0120	,0125	,0130	,0135	,0139
,0242	,0251	,0260	,0269	,0279
,0362	,0376	,0390	,0404	,0418
,0482	,0502	,0521	,0539	,0558
,0604	,0621	,0651	,0674	,0697
,0725	,0753	,0781	,0809	,0837
,0846	,0859	,0911	,0944	,0976
,0967	,1004	,1042	,1079	,1116
,1088	,1130	,1172	,1213	,1255

	31	32	33	34	35
30	,4325	,4465	,4604	,4744	,4883
40	,5767	,5953	,6139	,6325	,6511
50	,7209	,7442	,7674	,7907	,8139
60	,8651	,8930	,9209	,9488	,9707
70	1,0093	1,0418	1,0744	1,1069	1,1395
80	1,1535	1,1907	1,2279	1,2651	1,3023
90	1,2976	1,3395	1,3814	1,4232	1,4651
100	1,4418	1,4883	1,5349	1,5813	1,6279
110	1,5860	1,6372	1,6883	1,7395	1,7907
120	1,7302	1,7860	1,8418	1,8977	1,9535
130	1,8744	1,9349	1,9953	2,0558	2,1162
140	2,0186	2,0837	2,1488	2,2139	2,2790
150	2,1628	2,2325	2,3023	2,3721	2,4418
160	2,3069	2,3814	2,4558	2,5303	2,6046
170	2,4511	2,5302	2,6093	2,6884	2,7674
180	2,5953	2,6790	2,7628	2,8465	2,9302
190	2,7395	2,8279	2,9162	3,0046	3,0930
200	2,8837	2,9767	3,0697	3,2628	3,2558
210	3,0279	3,1256	3,2232	3,3209	3,4186
220	3,1720	3,2744	3,3767	3,4791	3,5814
230	3,3162	3,4232	3,5302	3,6342	3,7442
240	3,4164	3,5721	3,6837	3,7923	3,8069
250	3,6046	3,7209	3,8372	3,9534	4,0697
260	3,7488	3,8697	3,9907	4,1116	4,2321
270	4,8930	4,0186	4,1442	4,3697	4,3952
280	4,0372	4,1674	4,2976	4,4279	4,5581
290	4,1814	4,3163	4,4516	4,5860	4,7200
300	4,3256	4,4651	4,6046	4,7442	4,8837
1	,0141	,0148	,0153	,0158	,0162
2	,0288	,0297	,0307	,0316	,0325
3	,0432	,0466	,0460	,0474	,0488
4	,0576	,0595	,0614	,0632	,0651
5	,0720	,0744	,0767	,0790	,0813
6	,0865	,0893	,0921	,0948	,0975
7	,1009	,1042	,1074	,1107	,1139
8	,1153	,1190	,1228	,1265	,1302
9	,1297	,1339	,1381	,1423	,1465

36	37	38	39	40
,5023	,5163	,5302	,5442	,5581
,6697	,6883	,7069	,7246	,7441
,8372	,8604	,8837	,9069	,9302
1,0046	1,0325	1,0604	1,0883	1,1163
1,1721	1,2024	1,2372	1,2097	1,2033
1,3395	1,3767	1,4139	1,4546	1,4884
1,5069	1,5488	1,5907	1,6325	1,6744
1,6744	1,7209	1,7674	1,8129	1,8604
1,8418	1,8930	1,9442	1,9953	2,0465
2,0093	2,0651	2,1209	2,1767	2,2325
2,1767	2,2372	2,2976	2,3581	2,4186
2,3442	2,4093	2,4744	2,5395	2,6046
2,5162	2,5814	2,6511	2,7209	2,7900
2,6791	2,7504	2,8279	2,9023	2,9767
2,8465	2,9255	3,0046	3,0837	3,1627
3,0139	2,9767	3,1814	3,2651	3,3488
3,1849	3,2697	3,3581	3,4465	3,5349
3,3488	3,4418	3,5348	3,6279	3,7209
3,5162	3,6139	3,7116	3,8093	3,9069
3,6837	3,7860	3,8883	3,9907	4,0930
3,8511	3,9581	4,0651	4,1721	4,2790
4,0186	4,1302	4,2418	4,3535	4,4665
4,1860	4,3023	4,4186	4,5348	4,6511
4,3535	4,4744	4,5953	4,7162	4,8372
4,5209	4,6465	4,7720	4,8976	5,0232
4,6883	4,8186	4,7488	5,0790	5,2093
4,8558	4,9906	5,1255	5,2604	5,3953
5,0232	5,1627	5,3023	5,4418	5,5811
,0167	,0172	,0176	,0181	,0186
,0335	,0344	,0353	,0362	,0372
,0502	,0516	,0530	,0544	,0558
,0669	,0688	,0707	,0725	,0744
,0837	,0860	,0883	,0907	,0933
,1004	,1032	,1060	,1088	,1116
,1172	,1202	,1237	,1269	,1202
,1339	,1376	,1414	,1454	,1488
,1507	,1548	,1590	,1632	,1674

	41	42	43	44	45
30	,5720	,5860	,0000	,6139	,6279
40	,7628	,7814	,8000	,8186	,8372
50	,9535	,9767	1,0000	1,0232	1,0455
60	1,1442	1,1721	1,2000	1,2270	1,2558
70	1,3348	1,3674	1,4001	1,4325	1,4651
80	1,5255	1,5628	1,6000	1,6372	1,6744
90	1,7162	1,7581	1,8000	1,8418	1,8837
100	1,9069	2,9535	2,0000	3,0465	2,0930
110	2,0976	2,1488	2,2000	2,2511	2,3023
120	2,2884	2,3442	2,4000	2,4558	2,5126
130	2,4790	2,5395	2,6000	2,6604	2,7209
140	2,6697	2,7348	2,8000	2,8651	2,9302
150	2,8604	2,9302	3,0000	3,0697	3,1395
160	3,0511	3,1255	3,2000	3,2744	3,3488
170	3,2418	3,3289	3,4000	3,4790	3,5581
180	3,4325	3,5162	3,6000	3,6837	3,7614
190	3,6232	3,7116	3,8000	3,8883	3,9767
200	3,8139	3,9069	4,0000	4,0930	4,1860
210	4,0046	4,1023	4,2000	4,2976	4,3953
220	4,1953	4,2976	4,4000	4,5023	4,6046
230	4,3860	4,4930	4,6000	4,7069	4,8139
240	4,5767	4,6883	4,8000	4,9116	5,0232
250	4,7674	4,8837	5,0000	5,1162	5,2325
260	4,9581	5,0790	5,2000	5,3209	5,4418
270	5,1488	5,2744	5,4000	5,5255	5,6511
280	5,3395	5,4697	5,6000	5,7347	5,8604
290	5,5302	5,6651	5,8000	5,9347	6,0697
300	5,7209	5,8604	6,0000	6,1394	6,2790
1	,0190	,0195	,0200	,0204	,0209
2	,0381	,0390	,0400	,0409	,0418
3	,0572	,0586	,0600	,0613	,0628
4	,0762	,0781	,0800	,0818	,0837
5	,0953	,0976	,1000	,1023	,1046
6	,1144	,1172	,1200	,1228	,1265
7	,1335	,1367	,1400	,1432	,1465
8	,1525	,1562	,1600	,1637	,1674
9	,1716	,1758	,1800	,1841	,1883

46	47	48	49	50
,6418	,6558	,6697	,6837	,6976
,8558	,8744	,8930	,9116	,9302
1,0697	1,0930	1,1762	1,1395	1,1627
1,2837	1,3116	1,3395	1,3674	1,3953
1,4976	1,5302	1,5651	1,5953	1,6279
1,7116	1,7488	1,7860	1,8232	1,8604
1,9255	1,9674	2,0093	2,0511	2,0930
2,1395	2,1860	2,2325	2,2790	2,3255
2,3534	2,4046	2,4458	2,5069	2,5581
2,5674	2,6232	2,6790	2,7348	2,7906
2,7813	2,8418	2,9023	2,9618	3,0232
2,9553	3,0604	3,1255	3,1807	3,2558
3,2093	3,2790	3,3488	3,4186	3,4883
3,4232	3,4976	3,5720	3,6465	3,7269
3,6372	3,7162	3,7953	3,8744	3,9524
3,8511	3,9348	4,0186	4,1022	4,1860
4,0651	4,1534	4,2418	4,3202	4,4186
4,2790	4,3720	4,4651	4,5581	4,6511
4,4930	4,5906	4,6883	4,7860	4,8837
4,7069	4,8093	4,9116	5,0149	5,1162
4,9209	5,0279	5,1348	5,2419	5,3488
5,1348	5,2465	5,3581	5,4699	5,5813
5,3488	5,4651	5,5813	5,6976	5,8139
5,5627	5,6847	5,8046	5,9255	5,0465
5,7767	5,9055	6,0279	6,1534	6,2790
5,9906	6,1019	6,2511	6,3814	6,5116
6,2046	6,3305	6,4744	6,6093	6,7441
6,4186	6,5581	6,6976	6,8372	6,9767
,0214	0,218	,0223	,0228	,0232
,0427	0,437	,0446	,0455	,0465
,0641	0,655	,0669	,0683	,0697
,0855	0,874	,0893	,0911	,0930
,1069	,1093	,1116	,1139	,1162
,1283	,1311	,1339	,1367	,1395
,1497	,1530	,1565	,1595	,1628
,1711	,1748	,1786	,1823	,1860
,1925	,1967	,2000	,2051	,2093

	51	52	53	54	55
30	,7116	,7255	,7395	,7534	,7674
40	,9488	,9674	,9860	1,0046	1,0232
50	1,1862	1,2093	1,2325	1,2558	1,2790
60	1,4232	1,4511	1,4790	1,5069	1,5348
70	1,6604	1,6930	1,7255	1,7581	1,7906
80	1,8976	1,9348	1,9720	2,0093	2,0465
90	2,1348	2,1767	2,2180	2,2604	2,3023
100	2,3720	2,4186	2,4651	2,5116	2,5581
110	2,6093	2,6604	2,7116	2,7627	2,8139
120	2,8465	2,9023	2,9581	3,0139	3,0697
130	3,0837	3,1441	3,2046	3,2651	3,3255
140	3,3209	3,3860	3,4511	3,5162	3,5813
150	3,5581	3,6279	3,6976	3,7647	3,8372
160	3,7953	3,8697	3,9441	4,0186	4,0930
170	4,0325	4,1116	4,1906	4,2697	4,3488
180	4,2697	4,3534	4,4372	4,5209	4,6046
190	4,5069	4,5953	4,6837	4,7720	4,8612
200	4,7441	4,8372	4,9302	5,0232	5,1162
210	4,9813	5,0790	5,1763	5,2740	5,3720
220	5,2186	5,3299	5,4232	5,5255	5,6279
230	5,4558	5,5627	5,6697	5,7767	5,8837
240	5,6930	5,8046	5,9162	6,0249	6,1495
250	5,9302	6,0465	6,1627	6,2790	6,3953
260	6,1674	6,2883	6,4093	6,5302	6,6511
270	6,4046	6,5302	6,6558	6,7813	6,9069
280	6,6418	6,7720	6,9023	7,0325	7,1627
290	6,8790	7,0139	7,1488	7,2837	7,4180
300	7,1162	7,2558	7,3953	7,5348	7,6744
1	,0234	,0242	,0246	,0251	,0255
2	,0474	,0483	,0493	,0502	,0511
3	,0711	,0725	,0739	,0753	,0767
4	,0948	,0967	,0986	,1004	,1023
5	,1186	,1209	,1232	,1255	,1279
6	,1423	,1451	,1479	,1483	,1535
7	,1660	,1693	,1725	,1758	,1790
8	,1897	,1934	,1972	,1909	,2046
9	,2134	,2176	,2218	,2260	,2302

56	57	58	59	60
,7813	,7953	,8093	,8232	,8372
1,0418	1,0604	1,0790	1,0976	1,1162
1,3023	1,3255	1,3488	1,3720	1,3953
1,5627	1,5906	1,6186	1,6485	1,6774
1,8237	1,8558	1,8883	1,9209	1,9534
2,0837	2,1209	2,1581	2,1953	2,2325
2,3441	2,3860	2,4279	2,4697	3,5116
2,6046	2,6511	2,6976	2,7441	2,7906
2,8651	2,9162	2,9674	3,0186	3,0697
3,1255	3,1813	3,2372	3,2930	3,3488
3,3860	3,4465	3,5069	3,5674	3,6279
3,6465	3,7116	3,7767	3,8418	3,9069
3,9069	3,9767	4,0465	4,1162	4,1860
4,1674	4,2418	4,3162	4,3906	4,4651
4,4279	4,5069	4,5860	4,6651	4,7441
4,6883	4,7720	4,8558	4,9395	5,0232
4,9488	5,0372	5,1255	5,2139	5,3023
5,2093	5,3023	5,3953	5,4883	5,5813
5,4697	5,5674	5,6651	5,7627	5,8604
5,7212	5,8325	5,9348	6,0372	6,1395
5,9810	6,0976	6,2046	6,3116	6,4186
6,2521	6,3627	6,4744	6,5860	6,6976
6,5126	6,6279	6,7441	6,8604	6,9767
6,7730	6,8930	7,0149	7,1348	7,2558
7,0330	7,1581	7,2887	7,4093	7,5348
7,2930	7,4232	7,5534	7,6837	7,8139
7,5534	7,6883	7,8232	7,9581	8,0929
7,8139	7,9534	8,0930	8,2325	8,3720
,0260	,0265	,0269	,0274	,0279
,0521	,0530	,0539	,0548	,0558
,0781	,0795	,0809	,0823	,0837
,1042	,1060	,1079	,1097	,1116
,1302	,1325	,1348	,1372	,1395
,1561	,1590	,1618	,1648	,1674
,1823	,1855	,1888	,1921	,1953
,2083	,2120	,2158	,2195	,2232
,2344	,2386	,2427	,2469	,2511

	61	62	63	64	65
30	,8511	,8651	,8790	,8930	,9069
40	1,1348	1,1534	1,1720	1,1906	1,2093
50	1,4186	1,4418	1,4651	1,4883	1,5116
60	1,7023	1,7302	1,7581	1,7860	1,8139
70	1,9860	2,0186	2,0511	2,0837	2,1162
80	2,2697	2,3069	2,3441	2,3813	2,4186
90	2,5534	2,5953	2,6372	2,6790	2,7209
100	2,8372	2,8837	2,9302	2,9767	3,0232
110	3,1209	3,1720	3,2232	3,2744	3,3255
120	3,4046	3,4804	3,5167	3,5720	3,6279
130	3,6883	3,7488	3,8096	3,8697	3,9302
140	3,9720	4,0372	4,1025	4,1674	4,2325
150	4,2558	4,3255	4,3953	4,4651	4,5348
160	4,5395	4,6139	4,6883	4,7629	4,8372
170	4,8232	4,9023	4,9813	5,0604	5,1395
180	5,1869	5,1906	5,2744	5,3581	5,4418
190	5,3906	5,4790	5,5674	5,6558	5,7465
200	5,6740	5,7641	5,8604	5,9534	6,0465
210	5,9581	6,0558	6,1534	6,2511	6,3488
220	6,2418	6,3441	6,4465	6,5488	6,6511
230	6,5255	6,6325	6,7395	6,8466	6,9534
240	6,8098	6,9209	7,0355	7,1441	7,2548
250	7,0930	7,2093	7,3255	7,4418	7,5577
260	7,3767	7,4976	7,6186	7,7395	7,8594
270	7,6604	7,7860	7,9116	8,0372	8,1627
280	7,9441	8,0744	8,2046	8,3348	8,4651
290	8,2279	8,3627	8,4976	8,6325	8,7674
300	8,5116	8,6511	8,7906	8,9302	9,0697
1	,0283	,0288	,0293	,0297	,0302
2	,0567	,0576	,0586	,0595	,0604
3	,0851	,0865	,0879	,0893	,0907
4	,1135	,1153	,1172	,1190	,1209
5	,1418	,1442	,1465	,1488	,1511
6	,1702	,1730	,1758	,1786	,1814
7	,1986	,2018	,2051	,2083	,2116
8	,2269	,2307	,2344	,2381	,2418
9	,2553	,2595	,2637	,2679	,2720

66	67	68	69	70
,9209	,9348	,9488	,9627	,9767
1,2279	1,2465	1,2651	1,2837	1,302
1,5348	1,5581	1,5813	1,6046	1,6276
1,8418	1,8697	1,8976	1,9255	1,953
2,1488	2,1813	2,2189	2,2465	2,2790
2,4558	2,4930	2,5302	2,5674	2,6046
2,7627	2,8046	2,8465	2,8883	2,9302
3,0697	3,1162	3,1627	3,2093	3,2558
3,3767	3,4279	3,4790	3,5302	3,5813
3,6837	3,7395	3,7953	3,8511	3,9069
3,9906	4,0511	4,1116	4,1720	4,2325
4,2976	4,3627	4,4278	4,4930	4,5581
4,6046	4,6744	4,7440	4,8139	4,8837
4,9116	4,9860	5,0604	5,1348	5,2093
5,2186	5,2976	5,3767	5,4558	5,5348
5,5255	5,6093	5,6930	5,7767	5,8604
5,8325	5,9209	6,0099	6,0976	6,1860
6,1395	6,2325	6,3225	6,4185	6,5116
6,4465	6,5441	6,6418	6,7395	6,8372
6,7534	6,8558	6,9581	7,0604	7,1627
7,0604	7,1674	7,2744	7,3813	7,4883
7,3674	7,4790	7,5906	7,7023	7,8130
7,6744	7,7906	7,9069	8,0232	8,1295
7,9813	8,1023	8,2232	8,3441	8,4653
8,2883	8,4139	8,5395	8,6651	8,7906
8,5953	8,7255	8,8550	8,9860	9,1162
8,9023	9,0327	9,1720	9,3069	9,4418
9,2093	9,3488	9,4883	9,6279	9,7674
,0307	,0311	,0316	,0320	,0325
,0614	,0623	,0632	,0641	,0651
,0920	,0935	,0948	,0962	,0976
,1228	,1246	,1265	,1283	,1302
,1535	,1558	,1581	,1604	,1628
,1842	,1869	,1897	,1925	,1953
,2148	,2181	,2218	,2246	,2279
,2455	,2493	,2530	,2567	,2604
,2762	,2804	,2846	,2888	,2903

	71	72	73	74	75
30	,9906	1,0046	1,0186	1,0325	1,0465
40	1,3209	1,3395	1,3581	1,3767	1,3953
50	1,6511	1,6744	1,6976	1,7209	1,7441
60	1,9813	2,0093	2,0372	2,0651	2,0930
70	2,3116	2,3441	2,3767	2,4063	2,4418
80	2,6418	2,6790	2,7162	2,7534	2,7906
90	2,9720	3,0139	3,0558	3,0976	3,1395
100	3,3023	3,3488	3,3953	3,4418	3,4883
110	3,6325	3,6837	3,7348	3,7860	3,8372
120	3,9627	4,0186	4,0744	4,1302	4,1861
130	4,2930	4,3534	4,4139	4,4744	4,5348
140	4,6232	4,6833	4,7534	4,8186	4,8837
150	4,9534	5,0232	5,0930	5,1627	5,2325
160	5,2837	5,3581	5,4325	5,5069	5,5813
170	5,6139	5,6930	5,7720	5,8511	5,9301
180	5,9441	6,0279	6,1116	6,1953	6,2790
190	6,2744	6,3622	6,4511	6,5395	6,6279
200	6,6046	6,6976	6,7906	6,8837	6,9767
210	6,9348	7,0325	7,1302	7,2290	7,3255
220	7,2651	7,3674	7,4897	7,5620	7,6744
230	7,5953	7,7023	7,8093	7,9162	8,0232
240	7,9255	8,0372	8,1488	8,2604	8,3720
250	8,2558	8,3720	8,4883	8,6046	8,7209
260	8,5860	8,7069	8,8279	8,9488	9,0697
270	8,9162	9,0418	9,1674	9,2930	9,4186
280	9,2465	9,3767	9,5069	9,6372	9,7674
290	9,5767	9,7116	9,8465	9,9813	10,1162
300	9,9069	10,046	10,1860	10,3255	10,4651
1,0330	,0334	,0339	,0344	,0348	
2,0660	,0669	,0679	,0688	,0697	
3,0990	,1004	,1018	,1032	,1046	
4,1321	,1339	,1358	,1376	,1395	
5,1651	,1674	,1697	,1721	,1744	
6,1981	,2009	,2037	,2065	,2093	
7,2311	,2344	,2356	,2406	,2442	
8,2642	,2679	,2716	,2753	,2790	
9,2972	,3014	,3056	,3097	,3139	

76	77	78	79	80
1,0604	1,0744	1,0883	1,1023	1,1162
1,4139	1,4325	1,4511	1,4697	1,4883
1,7674	1,7906	1,8139	1,8372	1,8604
2,1209	2,1488	2,1767	2,2046	2,2325
1,4744	2,5069	2,5395	2,5720	2,6046
1,8279	2,8651	2,9023	2,9395	2,9767
3,1813	3,2232	3,2651	3,3069	3,3488
3,5348	3,5813	3,6279	3,6744	3,7209
3,8883	3,9395	3,9906	4,0418	4,0930
4,2418	4,2976	4,3534	4,4093	4,4657
4,5953	4,6558	4,7162	4,7767	4,8372
4,9488	5,0139	5,0790	5,1441	5,2093
5,3023	5,3720	5,4418	5,5116	5,5813
5,6558	5,7302	5,8046	5,8790	5,9534
6,0093	6,0883	6,1694	6,2465	6,3255
6,3627	6,4465	6,5302	6,6139	6,6976
6,7162	6,8046	6,8930	6,9813	7,0697
7,0697	7,1727	7,2558	7,3488	7,4418
7,4232	7,5209	7,6186	7,7162	7,8139
7,7767	7,8790	7,9813	8,0837	8,1860
8,1302	8,2371	8,3441	8,4511	8,5581
8,4837	8,6953	8,7069	8,8186	8,9302
8,8372	8,9534	9,0697	9,1860	9,3023
9,1906	9,3116	9,4325	9,5524	9,6744
9,5441	9,6697	9,7935	9,9209	10,0465
9,8976	10,0278	10,1581	10,2883	10,4186
10,2511	10,3860	10,5109	10,6558	10,7906
10,6046	10,7441	10,8837	11,0232	11,1627
,0353	,0358	,0362	,0367	,0372
,0707	,0717	,0725	,0734	,0744
,1060	,1074	,1088	,1102	,1116
,1414	,1432	,1451	,1469	,1488
,1767	,1790	,1813	,1837	,1860
,2121	,2148	,2176	,2204	,2232
,2474	,2506	,2539	,2572	,2604
,2828	,2865	,2902	,2939	,2976
,3181	,3223	,3265	,3307	,3248

	81	82	83	84	85
30	1,1302	1,1441	1,1581	1,1720	1,1860
40	1,5069	1,5255	1,5441	1,5627	1,5813
50	1,8837	1,9069	1,9302	1,9534	1,9767
60	2,2604	2,2882	2,3167	2,3441	2,3720
70	2,6372	2,6697	2,7023	2,7348	2,7674
80	3,0139	3,0511	3,0883	3,1255	3,1627
90	3,3906	3,4325	3,4741	3,5102	3,5581
100	3,7674	3,8139	3,8604	3,9069	3,9534
110	4,1441	4,1953	4,2465	4,2976	4,3488
120	4,5209	4,5167	4,6325	4,6883	4,7441
130	4,8976	4,9581	5,0186	5,0790	5,1395
140	5,2744	5,3395	5,4046	5,4697	5,5348
150	5,6511	5,7209	5,7906	5,8604	5,9302
160	6,0279	6,1023	6,1767	6,2511	6,3255
170	6,4046	6,4837	6,5627	6,6418	6,7209
180	6,7813	6,8651	6,9488	7,0325	7,1162
190	7,1581	7,2465	7,3347	7,4232	7,5116
200	7,5348	7,6279	7,7209	7,8139	7,9069
210	7,9116	8,0093	8,1069	8,2046	8,3023
220	8,2882	8,3906	8,4930	8,5953	8,6976
230	8,6651	8,7720	8,8790	8,9860	9,0930
240	9,0413	9,1534	9,2651	9,3767	9,4883
250	9,4186	9,5348	9,6511	9,7674	9,8837
260	9,7953	9,9162	10,0372	10,1581	10,2793
270	10,1720	10,2976	10,4232	10,5488	10,6744
280	10,5488	10,6790	10,8093	10,9395	11,0697
290	10,9255	11,0604	11,1953	11,3303	11,4651
300	11,3023	11,4418	11,5813	11,7209	11,8604
1	,0376	,0381	,0386	,0390	,0395
2	,0753	,0761	,0772	,0781	,0790
3	,1130	,1144	,1158	,1172	,1186
4	,1507	,1525	,1544	,1562	,1581
5	,1883	,1900	,1930	,1953	,1976
6	,2260	,2288	,2316	,2344	,2372
7	,2637	,2669	,2702	,2735	,2769
8	,3014	,3051	,3088	,3125	,3162
9	,3390	,3432	,3474	,3516	,3558

86	87	88	89	90
1,2000	1,2139	1,2279	1,2418	1,2558
1,6000	1,6189	1,6372	1,6558	1,6744
2,0000	2,0232	2,0465	2,0697	2,0930
2,4000	2,4279	2,4553	2,4837	2,5116
2,8000	2,8325	2,8652	2,8976	2,9302
3,2000	3,2372	3,2744	3,3116	3,3488
3,6000	3,6418	3,6837	3,7255	3,7674
4,0000	4,0465	4,0930	4,1395	4,1860
4,4000	4,4511	4,5023	4,5534	4,6046
4,8000	4,8558	4,9116	4,9674	5,0232
5,2000	5,2604	5,3209	5,3813	5,4418
5,6000	5,9651	5,7302	5,7953	5,8604
6,0000	6,0679	6,1395	6,2093	6,2790
6,4000	6,4744	6,5482	6,6232	6,6976
6,8000	6,8760	6,9581	7,0372	7,1162
7,2000	7,2837	7,3674	7,4511	7,5348
7,6000	7,6885	7,7767	7,8651	7,9534
8,0000	8,0950	8,1860	8,2790	8,3720
8,4000	8,4778	8,5953	8,6930	8,7906
8,8000	8,8702	9,0046	9,1069	9,2093
9,2000	9,3709	9,4139	9,5209	9,6279
9,6000	9,7016	9,8232	9,9348	10,0465
10,0000	10,1162	10,2325	10,3488	10,4652
10,4000	10,5209	10,6419	10,7627	10,8837
10,8000	10,9255	11,0511	11,1767	11,3023
11,2000	11,3302	11,4604	11,5906	11,7209
11,6000	11,7348	11,8697	11,9046	12,1395
12,0000	12,1395	12,2700	12,4186	12,5581
,0400	,0404	,0409	,0413	,0418
,0800	,0809	,0818	,0828	,0832
,1200	,1214	,1227	,1242	,1255
,1600	,1619	,1637	,1655	,1674
,2000	,2023	,2046	,2066	,2093
,2400	,2428	,2455	,2483	,2511
,2800	,2832	,2865	,2897	,2930
,3200	,3237	,3274	,3311	,3348
,3600	,3642	,3683	,3725	,3767

	91	92	93	94	95
30	1,2695	1,2837	1,2976	1,3116	1,3255
40	1,6936	1,7171	1,7302	1,7488	1,7674
50	2,1162	2,1395	2,1627	2,1866	2,2093
60	2,5395	2,5674	2,5953	2,6232	2,6511
70	2,9627	2,9953	3,0279	3,0604	3,0936
80	3,3860	3,4232	3,4604	3,4970	3,5348
90	3,8093	3,8512	3,8939	3,9348	3,9767
100	4,2325	4,2760	4,3255	4,3720	4,4186
110	4,6558	4,7069	4,7581	4,8093	4,8604
120	5,0790	5,1748	5,1906	5,2465	5,3023
130	5,5023	5,5627	5,6232	5,6830	5,7441
140	5,9255	5,9906	6,0558	6,1209	6,1860
150	6,3488	6,4186	6,4883	6,5581	6,6279
160	6,7720	6,8465	6,9209	6,9953	7,0697
170	7,1953	7,2744	7,3534	7,4325	7,5116
180	7,6186	7,7022	7,7860	7,8697	7,9534
190	8,0418	8,1202	8,2186	8,3069	8,3953
200	8,4651	8,5813	8,6512	8,7441	8,8373
210	8,8883	8,9860	9,0837	9,1813	9,2790
220	9,3116	9,4139	9,5162	9,6186	9,7209
230	9,7348	9,8418	9,9488	10,0558	10,1627
240	10,1581	10,2697	10,3813	10,4930	10,6046
250	10,5813	10,6976	10,8139	10,9302	11,0465
260	11,0047	11,1125	11,2465	11,3670	11,4883
270	11,4279	11,5534	11,6790	11,8040	11,9302
280	11,8511	11,9813	12,1106	12,2418	12,3720
290	12,2544	12,4093	12,5444	12,6790	12,8139
300	12,6976	12,8372	12,9767	13,1162	13,2558
1	,0423	,0427	,0432	,0437	,0442
2	,0846	,0858	,0865	,0874	,0883
3	,1269	,1283	,1297	,1311	,1325
4	,1693	,1717	,1730	,1748	,1767
5	,2116	,2139	,2162	,2186	,2209
6	,2539	,2567	,2595	,2623	,2651
7	,2962	,2995	,3028	,3060	,3093
8	,3386	,3423	,3460	,3497	,3534
9	,3809	,3851	,3893	,3924	,3976

96	97	98	99	100
1,3395	1,3534	1,3674	1,3813	1,3953
1,7860	1,8046	1,8232	1,8418	1,8604
2,2325	2,2558	2,2790	2,3023	2,3258
2,6790	2,7069	2,7348	2,7627	2,7907
3,1255	3,1581	3,1906	3,2232	3,2558
3,5720	3,6093	3,6465	3,6837	3,7209
4,0186	4,0604	4,1023	4,1441	4,1860
4,4651	4,5116	4,5581	4,6046	4,6511
4,9116	4,9627	5,0139	5,0651	5,1162
5,3581	5,4139	5,4697	5,5259	5,5813
5,8046	5,8651	5,9255	5,9860	6,0465
6,2511	6,3162	6,3813	6,4465	6,5116
6,6976	6,7674	6,8372	6,9069	6,9767
7,1441	7,2186	7,2930	7,3674	7,4418
7,5906	7,6697	7,7488	7,8279	7,9069
8,0372	8,1209	8,2046	8,2886	8,3720
8,4837	8,5720	8,6604	8,7488	8,8372
8,9302	9,0232	9,1162	9,2093	9,3023
9,3767	9,4744	9,5720	9,6679	9,7674
9,8232	9,9255	10,0279	10,1302	10,2325
10,2697	10,3767	10,4837	10,5906	10,6976
10,7162	10,8279	10,9391	11,0511	11,1627
11,1627	11,2790	11,3953	11,5116	11,6279
11,6092	11,7302	11,8351	11,9720	12,0930
12,0558	12,1813	12,3069	12,4325	12,5581
12,5023	12,6325	12,7627	12,8930	13,0232
12,9488	13,0837	13,2186	13,3534	13,4883
13,3952	13,5348	13,6744	13,8139	13,9534
14,0446	14,0451	14,0455	14,0460	14,0465
14,0893	14,0902	14,0911	14,0921	14,0930
14,1339	14,1353	14,1367	14,1388	14,1395
14,1786	14,1804	14,1823	14,1842	14,1860
14,2232	14,2255	14,2279	14,2302	14,2325
14,2679	14,2707	14,2735	14,2762	14,2790
14,3125	14,3158	14,3190	14,3223	14,3255
14,3572	14,3609	14,3646	14,3683	14,3720
14,4018	14,4060	14,4102	14,4144	14,4186

	101	102	103	104	105
30	1,4093	1,4232	1,4372	1,4511	1,4651
40	1,8790	1,8976	1,9162	1,9348	1,9534
50	2,3488	2,3720	2,3958	2,4186	2,4418
60	2,8186	2,8465	2,8744	2,9023	2,9302
70	3,2883	3,3209	3,3354	3,3806	3,4189
80	3,7581	3,7953	3,8325	3,8697	3,9069
90	4,2279	4,2697	4,3119	4,3534	4,3953
100	4,6976	4,7441	4,7909	4,8372	4,8837
110	5,1674	5,2180	5,2697	5,3209	5,3720
120	5,6372	5,6930	5,7488	5,8046	5,8604
130	6,1069	6,1674	6,2279	6,2883	6,3488
140	6,5767	6,6418	6,7069	6,7720	6,8372
150	7,0465	7,1102	7,1860	7,2550	7,3256
160	7,5162	7,5906	7,6651	7,7395	7,8139
170	7,9860	8,0651	8,1441	8,2232	8,3023
180	8,4558	8,5395	8,6232	8,7069	8,7907
190	8,9255	9,0139	9,1023	9,1906	9,2790
200	9,3953	9,4883	9,5813	9,6744	9,7674
210	9,8651	9,9627	10,0060	10,1581	10,2558
220	10,3249	10,4372	10,5395	10,6418	10,7442
230	10,8049	10,9116	11,0186	11,1255	11,2325
240	11,2744	11,3860	11,4976	11,6093	11,7206
250	11,7442	11,8604	11,9767	12,0930	12,2093
260	12,2139	12,3348	12,4558	12,5763	12,6976
270	12,6832	12,8093	12,9345	13,0604	13,1860
280	13,1535	13,2837	13,4139	13,5441	13,7446
290	13,6232	13,7581	13,8930	14,0279	14,1627
300	14,0930	14,2325	14,3721	14,5116	14,6511
1	,0469	,0474	,0479	,0483	,0488
2	,0939	,0948	,0958	,0967	,0976
3	,1409	,1423	,1437	,1451	,1465
4	,1879	,1897	,1916	,1935	,1953
5	,2348	,2372	,2395	,2418	,2442
6	,2818	,2846	,2874	,2902	,2930
7	,3288	,3321	,3353	,3386	,3418
8	,3758	,3795	,3832	,3869	,3907
9	,4228	,4269	,4311	,4353	,4395

106	107	108	109	110
1,4790	1,4930	1,5062	1,5209	1,5349
1,9721	1,9907	2,0092	2,0278	2,0465
2,4651	2,4883	2,5116	2,5348	2,5581
2,9581	2,9860	3,0139	3,0418	3,0697
3,4511	3,4837	3,5162	3,5488	3,5814
3,9442	3,9814	4,0186	4,0558	4,0930
4,4372	4,4790	4,5209	4,5628	4,6046
4,9302	4,9767	5,0232	5,0697	5,1163
5,4232	5,4744	5,5255	5,5767	5,6279
5,9163	5,9721	6,0279	6,0837	6,1395
6,4093	6,4697	6,5302	6,5907	6,6511
6,9023	6,9674	7,0325	7,0976	7,1628
7,3953	7,4651	7,5348	7,6046	7,6744
7,8883	7,9628	8,0372	8,1116	8,1860
8,3814	8,4604	8,5395	8,6186	8,6976
8,8744	8,9581	9,0418	9,1256	9,2093
9,3674	9,455	9,5442	9,6325	9,7209
9,8604	9,9534	10,0465	10,1395	10,2325
10,3334	10,4311	10,5288	10,6265	10,7242
10,8165	10,9188	11,0211	11,1235	11,2258
11,3395	11,4465	11,5535	11,6604	11,7674
11,8325	11,9442	12,0558	12,1674	12,2790
12,3255	12,4418	12,5581	12,6744	12,7907
12,8186	12,9395	13,0604	13,1814	13,3023
12,3116	13,4372	13,5628	13,6883	13,8139
13,8046	13,9348	14,0651	14,1953	14,3256
14,2976	14,4325	14,5674	14,7023	14,8372
14,7907	14,9302	15,0697	15,2093	15,3488
,0493	,0978	,0502	,0507	,0511
,0986	,0995	,1004	,1014	,1023
,1479	,1493	,1506	,1521	,1535
,1972	,1091	,2009	,2028	,2046
,2465	,2488	,2511	,2535	,2558
,2958	,2986	,3014	,3042	,3069
,3451	,3483	,3516	,3549	,3581
,3944	,3981	,4018	,4056	,4093
,4437	,4479	,4521	,4563	,4604

	111	112	113	114	115
30	1,5488	1,5628	1,5767	1,4906	1,6046
40	2,0651	2,0837	2,1023	2,1209	2,1395
50	2,5814	2,6046	2,6279	2,6511	2,6744
60	3,0976	3,1256	3,1534	3,1813	3,2093
70	3,6139	3,6465	3,6790	3,7110	3,7441
80	4,1302	4,1674	4,2046	4,2418	4,2790
90	4,6465	4,6883	4,7302	4,7720	4,8139
100	5,1628	5,2093	5,2558	5,3023	5,3488
110	5,6790	5,7303	5,7813	5,8325	5,8837
120	6,1953	6,2511	6,3069	6,3627	6,4186
130	6,7116	6,7721	6,8325	6,8930	6,9534
140	7,2279	7,2930	7,3581	7,4232	7,4883
150	7,7442	7,8139	7,8837	7,9534	8,0232
160	8,2604	8,3348	8,4093	8,4837	8,5581
170	8,7767	8,8558	8,9348	9,0139	9,0930
180	9,2930	9,3767	9,4604	9,5441	9,6279
190	9,8093	9,8976	9,9860	10,0744	10,1627
200	10,3256	10,4186	10,5116	10,6046	10,6976
210	10,8418	10,9395	11,0372	11,1348	11,2325
220	11,3581	11,4604	11,5627	11,6651	11,7674
230	11,8744	11,9814	12,0883	12,1953	12,3023
240	12,3906	12,5023	12,6139	12,7255	12,8372
250	12,9069	13,0232	13,1395	13,2558	13,3720
260	13,4232	13,5442	13,6651	13,7860	13,9069
270	13,9395	14,0651	14,1906	14,3162	14,4418
280	14,4458	14,5860	14,7162	14,8465	14,9767
290	14,9721	15,1069	15,2418	15,3767	15,5116
300	15,4883	15,6279	15,7674	15,9069	15,0465
1	0516	0521	0525	0530	0535
2	1032	1042	1051	1060	1069
3	1548	1562	1576	1590	1604
4	2065	2083	2102	2121	2136
5	2581	2604	2628	2651	2674
6	3097	3125	3125	3181	3209
7	3614	3646	3679	3711	3744
8	4130	4167	4204	4242	4279
9	4646	4688	4772	4730	4814

116	117	118	119	120
1,6186	1,6325	1,6465	1,6604	1,6744
2,1581	2,1767	2,1953	2,2139	2,2325
2,6976	2,7209	2,7411	2,7676	2,7906
3,2372	3,2651	3,2930	3,3209	3,3488
3,7767	3,8093	3,8418	3,8744	3,9069
4,3162	4,3534	4,3906	4,4279	4,4651
4,8558	4,8976	4,6395	4,9813	5,0232
5,3953	5,4418	5,4883	5,5348	5,5813
5,9348	5,9860	6,0372	6,0883	6,1395
6,4744	6,5302	6,5860	6,6418	6,6976
7,0139	7,0744	7,1348	7,1953	7,2558
7,5534	7,6186	7,6837	7,7488	7,8139
8,0930	8,1627	8,2325	8,3023	8,3720
8,6325	8,7069	8,7813	8,8558	8,9302
9,1720	9,2511	9,3302	9,4093	9,4883
9,7116	9,7953	9,8790	9,9627	10,0465
10,2511	10,3395	10,4280	10,5162	10,6046
10,7906	10,8837	10,9767	11,0697	11,1627
11,3302	11,4279	11,5255	11,6232	11,7209
11,8697	11,9720	12,0744	12,1767	12,2790
12,4093	12,5162	12,6234	12,7302	12,8372
12,9488	13,0604	13,1720	13,2837	13,3953
13,4883	13,6046	13,7219	13,8372	13,9534
14,0279	14,1148	14,2696	14,3906	14,5116
14,5674	14,6930	14,8180	14,9441	15,0697
15,1069	15,2372	15,3674	15,4976	15,6279
15,6465	15,7813	15,9164	16,0511	16,1860
16,1860	16,3255	16,4651	16,6046	16,7441
,0539	,0544	,0548	,0553	,0558
,1079	,1088	,1097	,1107	,1116
,1618	,1632	,1646	,1660	,1674
,2158	,2176	,2195	,2214	,2232
,2697	,2721	,2744	,2767	,2790
,3237	,3265	,3293	,3321	,3348
,3776	,3809	,3842	,3874	,3907
,4316	,4353	,4390	,4428	,4465
,4855	,4897	,4629	,4081	,4023

To gauge a Couch which lies in the Form of a Parallelogram.

R U L E.

Find the Breadth in the Top of the Table, and the Length in the first Column, and in the Angle of Meeting, you'll have the Content in Malt Bushels at one Inch Deep.

E X A M P L E I.

Let a Couch be proposed, whose Length is 199 Inches, and Breadth 99 ; and the Area be required.

Look for 99 in the Top of the Table, and under that, and against 190 you'll find 8,7488 and against 9,

4144

their Sum is

9,1632

The Area required ; which if you multiply by the Depth, produceth the whole Content in Malt Bushels.

E X A M P L E II.

Admit the Length of a Couch to be 559 Inches, and Breadth 342 ; what's the Area ?

1. Look

1. Look for 100 at the Top, and under it,
and against 300 you'll find 13,9534
against 200 you'll find 9,3023
against 50 you'll find 2,2358
against 9 you'll find 4186
their Sum is 26,0001

and so much is the Area of 559 Inches long and 100 broad; but because 'tis 300, set it down as in the Margin.

2. Look 42 in the Top, and under it, and
against 300 you'll find 5,8604
against 200 you'll find 3,9069
against 50 you'll find 9767
and against 9 you'll find 1758
their Sum is 10,9198

the Area of 559 long, and 42 broad 78,0003
to which add 78,0003, the Area of 559
long, and 300 broad, and the Sum will be
88,9201, which is the Area of a Couch, whose
Breadth is 342 Inches, and Length 559; and
the like may be done by any other which ex-
ceeds the Table.

To gauge a Triangle by the Table

R U L E I.

Find half the Perpendicular in the Top of
the Table; then under that, and against the
Base you'll have the Area. *E X-*

E X A M P L E II.

Let the Perpendicular of the Triangle proposed be 86 Inches, and the Base 255; what's the Area?

Look in the Top of the Table for 43, and under that, and against 250 you'll find 5,0000 and against 5,

0,1000
5,1000

their Sum, viz.

is the Area required.

I might here proceed, and show how to find the Areas of all other right-lined Figures, and also the Contents of such Tuns to which any right-lined Superficies may be a Base; but if what is already laid down in this Book, be well understood, the Learner will be able to perform any such Question without farther Directions.

A practical Method of finding the Area of any Couch, without either Pen, Sliding Rule, or Table, as 'twas delivered to me by my ingenious Friend Mr. Fitz Lambe, now Supervisor in Worcester Collection.

The Rules for Couch Gauges are these.

If the Length or Breadth be 215, or 2,15, the other is the Area. H

If	430 or 43	Multiply by	2
	64.5 or 645		3
	860		4
	107,5		5
	129		6
	150,5		7
	172,		8
	193,5		9

If the Dimensions be otherwise, it may be performed near the Truth by the Observations following.

If the Length and Breadth be near the same, take from one and add the like Number to the other; so that you make one of them equal to one of the above Numbers.

If the Length be double, (or near double) the Breadth, what you take from the Length must be but Half, or not quite Half, added to the Breadth: Or if you take from the Breadth, you must add double, or rather more than double to the Length, and so in Proportion, and then proceed as above.

A TABLE to gauge right-lined Figures; when the Dimensions are taken in Inches and decimal Parts, as in Cisterns, &c.

	0	1	2	3	4	5
1	,00046	,000516	,000558	,000604	,000651	,000697
2	,000930	,000976	,000023	,001069	,001116	,001162
3	,00139	,001442	,001488	,001534	,001581	,001628
4	,001860	,001900	,001953	,002000	,002046	,002093
5	,002325	,002372	,002418	,002466	,002511	,002558
6	,002790	,002837	,002883	,002930	,002976	,003023
7	,003256	,003302	,003344	,003395	,003442	,003488
8	,003721	,003767	,003819	,003860	,003907	,003953
9	,004186	,004232	,004279	,004325	,004372	,004418
10	,004651	,004697	,004744	,004790	,004837	,004884
11	,005116	,005163	,005209	,005256	,005302	,005349
12	,005581	,005628	,005674	,005721	,005767	,005814
13	,006046	,006093	,006139	,006180	,006232	,006279
14	,006511	,006558	,006604	,006651	,006697	,006744
15	,006977	,007023	,007070	,007116	,007163	,007209
16	,007442	,007488	,007531	,007581	,007628	,007674
17	,007907	,007953	,008000	,008046	,008093	,008139
18	,008372	,008418	,008466	,008511	,008558	,008604
19	,008837	,008883	,008930	,008976	,009023	,009069
20	,009302	,009348	,009395	,009441	,009488	,009534
21	,009767	,009813	,009860	,009906	,009953	,010000
22	,010232	,010279	,010325	,010372	,010418	,010465
23	,010697	,010744	,010790	,010837	,010883	,010930
24	,011168	,011209	,011255	,011302	,011348	,011395
25	,011628	,011674	,011720	,011767	,011813	,011860
26	,012093	,012139	,012186	,012232	,012279	,012325
27	,012558	,012604	,012651	,012697	,012744	,012790
28	,013023	,013069	,013116	,013162	,013209	,013255
29	,013483	,013534	,013581	,013627	,013675	,013720
30	,013953	,014000	,014046	,014093	,014139	,014186
31	,014418	,014465	,014511	,014558	,014604	,014651
32	,014883	,014930	,014976	,015023	,015069	,015116
33	,015349	,015395	,015441	,015488	,015535	,015581
34	,015813	,015860	,015907	,015953	,016000	,016046
35	,016279	,016325	,016372	,016418	,016465	,016511
36	,016744	,016790	,016837	,016883	,016930	,016976
37	,017209	,017255	,017302	,017348	,017395	,017442
38	,017614	,017660	,017707	,017753	,017800	,017846
39	,018139	,018186	,018232	,018279	,018325	,018372
40	,018604	,018651	,018697	,018744	,018790	,018837
41	,019067	,019116	,019162	,019209	,019250	,019302
42	,019534	,019581	,019627	,019674	,019720	,019767
43	,020002	,020046	,020093	,020139	,020186	,020232

6	7	8	9	A	B
,000744	,000750	,000837	,000884	43	,02
,001209	,001255	,001302	,001348	86	,04
,001674	,001721	,001767	,001814	129	,06
,002139	,002186	,002232	,002279	172	,08
,002604	,002651	,002697	,002744	215	,10
,003069	,003116	,003163	,003209	258	,12
,003535	,003581	,003628	,003673	301	,14
,004000	,004046	,004093	,004139	344	,16
,004465	,004511	,004558	,004604	387	,18
,004930	,004977	,005023	,005069	430	,20
,005395	,005442	,005488	,005535	473	,22
,005860	,005907	,005953	,006000	516	,24
,006325	,006372	,006418	,006465	559	,26
,006790	,006837	,006884	,006930	602	,28
,007256	,007302	,007348	,007395	645	,30
,007721	,007767	,007814	,007860	688	,32
,008186	,008232	,008279	,008325	731	,34
,008651	,008697	,008744	,008790	774	,36
,009116	,009162	,009209	,009255	817	,38
,009581	,009627	,009674	,009720	860	,40
,010046	,010093	,010139	,010186	903	,42
,010511	,010558	,010604	,010651	946	,44
,010976	,011023	,011069	,011116	989	,46
,011441	,011488	,011534	,011581	1032	,48
,011906	,011953	,012000	,012046	1075	,50
,012372	,012418	,012465	,012511	1118	,52
,012837	,012883	,012930	,012976	1161	,54
,013302	,013348	,013395	,013441	1204	,56
,013767	,013813	,013860	,013906	1247	,58
,014232	,014279	,014325	,014372	1290	,60
,014697	,014744	,014790	,014837	1337	,62
,015162	,015209	,015255	,015302	1376	,64
,015628	,015674	,015721	,015767	1419	,66
,016093	,016139	,016186	,016232	1462	,68
,016558	,016604	,016651	,016697	1505	,70
,017023	,017069	,017116	,017162	1548	,72
,017488	,017534	,017581	,017627	1591	,74
,017953	,018000	,018046	,018093	1634	,76
,018418	,018465	,018511	,018558	1677	,78
,018883	,018930	,018976	,019023	1720	,80
,019344	,019395	,019442	,019488	1763	,82
,019814	,019855	,019907	,019952	1806	,84
,020279	,020325	,020372	,020418	1840	,86

The Use of the preceding Table for Cistern Gauges, &c.

C A S E I.

If the Length or Breadth of a Rectangular Cistern, &c. be any Number in the Column under A; multiply the other by the Decimal answering thereto under B, and the Product will be the Area at one Inch Deep: Which multiplied by the whole Depth, produceth the whole Content in Malt Bushels, and decimal Parts.

E X A M P L E I.

Let a Cistern be proposed, whose Length is 257 Inches, and Breadth 172; and the Area at one Inch Deep, be required.

First look under A for either of the two Numbers, viz. 257, or 172, and there you'll find 172; and against it under B, stands ,08, by which you are to multiply 257, and the Product will be 20,56, which is the Area required, i. e. 20 Bushels and $\frac{6}{3}$.

E X A M P L E II.

Given the Length of a Cistern or Couch 989 Inches, and Breadth 771, to find the Area.

Look under A, and there you'll find 989; against which under B, you'll find ,46 for a Multiplier; by which multiply 771, and the Product will be 354,66, the Area required.

C A S E II.

If neither the Length or Breadth can be found under A, you may take the next Number less under either of them, and note what Decimal stands against it under B; then take the Difference of the Number proposed, and that next less which you find under A, and enter the first Column of the Table, and against that (and under the Tenths, if any be) you'll find another decimal Number, which added to your before-noted Decimal which you found under B, will give a Multiplier to be used as before.

E X A M P L E.

Let the Length be 1158,5, and Breadth 980,8, and the Area be required. First

First I look under A, and find not just 980,8, but the next to it less is 946, against which stands ,44 under B, which I note; then I take 946 out of 980,8, and the Remains will be 34,8; look 34 in the first Column, and against it under ,8 you'll find ,0161861, which add to the Decimal before found, *viz.* ,44, and the Sum will be ,456186, by which multiply 1158,5, and the Product will be 528,491, &c. the Area required, and so of any other: And though I have used 6 decimal Places here, yet four will be sufficient in most Cases. And thus having shewn the Use of this little, yet most extensive Table; I shall next endeavour to shew any young Officer, how, when he has many Gauges to cast up by the Sliding Rule, he may do them with that Instrument at one Set without finding the Area, or a Mean first, as is common.

The Way is this.

Take the Sliding Rule in your Left-hand, and turn the Side marked with A. B. num. *Seg. ly.* towards you; this done, with your Right-hand draw out the Sliding-piece C, and place the Rabbit of the same which is next the Line of Numbers on the Corner of the Sliding Rule, which is at the Line of *Seg. ly.* so as that the 1 at the Beginning of the Line of Numbers on the Sliding-piece noted with B, may be against 10 on the Line of Numbers on the Sliding-piece C, or that the End of the Line of Numbers on the Sliding-piece C, may stand against the Beginning of the Line of Numbers on the Sliding-piece B. When the Piece is set as it ought to be, it will be perpendicular to the Side A. B. num. *Seg. ly.* and you may keep it in that Position with the Thumb of your Left-hand; and if you hold the Rule so, as 'tis now supposed to be placed, the Part of the Line of Inches which is on the Inside of the Sliding-piece C, will be towards you and lowermost, and the Area's thereto belonging uppermost. When the Sliding-piece C is placed on the Corner of the Rule at the Line of *Seg. ly.* as above directed, slip it along with your Right-hand, till 2150, in the Line of Numbers on the same stands exactly on the Line marked

marked with 100 on the Line of *Seg. ly.* and there keep it with the Thumb of your Left-hand placed on the Inside thereof: And as that Piece is now set, you may at one Set of the Piece B, answer any such Question as is set below.

Let a Couch be proposed, whose Length is 89 Inches, Breadth 64, and Depth 22; and its Content be required.

The Rule being set as above directed, move with your Right-hand the Sliding-piece B, till 22 (the Depth proposed) on the Line of Numbers there comes against 64 on the Line of Numbers on the Piece C, (which with Use you will do very exact,) then against 89 on the Line A, you'll find 58, 28 on the Line B; and such is the Content of that Couch.

E X A M P L E II.

What's the Content of a Cistern, whose Length is 89,5 Inches, Breadth 64,2, and Depth 46,5.

The Sliding-piece C remaining in the same Posture, as above, bring 46,5 in the Line of Numbers on the Piece B, to 64,2 on the Line of Numbers on the Piece C; then against 89,5 on the Line A, you'll find 124,27 on B, and so much the Cistern will contain. And here you are to remember always to set the Depth on the Line of Numbers on the Piece B, to either the Length or the Breadth in the Line of Numbers on the Piece C; then against the Length or Breadth on the Line A, you'll have the Content required on B: But there may be a Line of Numbers so contrived, instead of the Line of *Seg. ly.* as to work with those on the Piece B, and answer all Questions of this Kind very nicely; which I hope will be taken Notice of by some ingenious Soul, whose Business it more immediately belongs to. And now having brought to an End what I did at first Design, and made every Thing (that I thought convenient to handle) as plain as possible; I hope, I shall (by the Acceptance of this) be encouraged to appear again in Publick with some Curiosities in the noble Art; which I do designedly at present conceal.

A P P E N -

A N

APPENDIX.

THE Preceding Work being chiefly intended for the Benefit of young Officers in the Excise, or others who endeavour to get their Bread that way, was the Reason that so little is said about Measuring of Boards, Timber, Stone, Wainscoting, Glazing, &c. but for the sake of the several Artificers employed in Building it was thought convenient to add what follows,

Board Measure.

There is a Board whose Breadth is 16 Inches, I demand how many Inches in Length must be taken to make one Foot Square.

1. *By the Pen.*

Divide 144 (the Number of Square Inches in a Square Foot) by any given Breadth, and the Quotient will be the Length required, and in this Case it will be 9 Inches.

2. *By the Sliding Rule.*

Set 16 upon B to 12 upon A, then against 12 upon B you'll have 9 upon A.

Y3. *By*

3. *By Gunter's Line.*

Extend your Compasses from 16 to 12, and the same Extent turn'd the same way from 12 will reach to 9 as before, and so of any other Breadth.

Given the Breadth of a Board in Inches and Length in Feet, to find the Content in Feet.

1. *By the Pen.*

Multiply the Length of the Board in Feet, by the Breadth in Inches, and divide the Product by 12, the Quotient will be the Content of the Board in Square Feet.

E X A M P L E.

Given the Breadth of a Board 14 Inches, and Length 22 Feet, what's its Content, *Facit.* $25\frac{2}{3} = 25 : 8$.

2. *By the Sliding Rule.*

Set 12 upon B to 14 upon A, then against 22 upon B, you'll have $25\frac{2}{3}$, or $25 : 8$

3. *By Gunter's Line.*

Extend your Compasses from 12 to 14, and that Extent turn'd the same way from 22, will reach to $25\frac{2}{3} =$ Feet Inch.

$25 : 8$ the Content as before.

N. B. That upon one Side of the Two Foot Rule you have a Line of Board Measure, and another for Timber Measure: That for Board Measure has a little Table at the left End of it, set on thus.

1	2	3	4	5	6	7 &c. to about 36
12	6	4	3	2	2	
0	0	0	0	4	0	

The

The Use of this Line is to know how much in Length of any Board whose Breadth is 36 Inches or less, will go to make one Foot Square. Thus, let the Breadth of a Board be 1 Inch, then 12 Feet in Length must be taken to make one Foot Square. If the Breadth is 2 Inches, then you must take 6 Feet, if 5 Inches Broad, then 2 Feet and 4 Inches, if 6 Broad, then 2 Feet. But if the Breadth should be 9 Inches, then look along the Line towards the Right Hand for 9, and against that on the opposite Side of the Rule you'll have 16 Inches for the Length required. If the given Breadth had been 18 Inches, look for 18 in the same Line, and against that on the other Side you'll find 8 Inches, and so many must be taken of the Length of that Board to make one Foot Square.

In Practice you need only find the given Breadth. Suppose 10 Inches upon the Line of Board Measure, then all the Distance between that, and that End of the Rule which is to the Right Hand, is the Length of a Foot of that Board, and so many times as that Distance is found in the Length of the Board, so many Square Feet does the same contain. Now if a Board thus measured, or otherwise as before, should be the uppermost Board of a Stock, you must multiply its Content by the Number of Boards in the Stock, and the Product will be the Content of them all.

Sawyer's Work.

These allow 120 Feet to the Hundred, for which they have about 2 Shillings, or 2 Shillings and 6 Pence. So if you'd find the Content of a Stock of Boards in such Measure, and having found the Content of one Board by any of the Ways abovementioned, you must then set 120 upon B, to the Number of Kerfs or Cuts (which are ever less by one than the Number of Boards in the Stock) upon A; then against the Content of one Board upon B, you'll have the Number of Sawyers Hundreds upon A, (if

Y 2

there

There is a Hundred in the Stock) the Decimal Parts (if any) may be reduc'd to Feet, by setting 100 upon B to 120 upon A; then against the Decimal Parts upon B you'll have the odd Feet upon A, or for every tenth reckon 12 Feet, and every hundredth reckon 1.2 Feet. According to this, if a Stock contained 24 Boards, and the Content of one of them be 30 Feet, you'll find the Sawing to be 500 and 90 Feet over.

By the Pen.

$$\begin{array}{rcl}
 \text{Say as } 120 : 23 :: 30 : 5.75 : 5 : 90 & \text{facit. } h. & f. \\
 & 23 & \\
 \hline
 120 \overline{) 690} & h. & f. \quad h. \\
 & 600 & (5 : 90 = 5\frac{1}{4} \\
 \hline
 & 90 & \\
 \hline
 \end{array}$$

By the Sliding Rule.

Set 120 upon B to 23 upon A, then against 30 upon B, you'll find 5.75 upon A, that is, five hundred and three Quarters of a hundred.

Square Timber.

There is a Square Piece of Timber whose Side is 16 Inches, I demand how many Inches of the Length thereof must be taken to make one Foot solid.

By the Pen.

Divide 1728 (the Inches in a solid Foot) by the Square of the Side, and the Quotient will be the Answer: So if the Side of the Square be 16 Inches, then 6.75 Inches must be

be taken to make one Foot solid. If the Side be 9 Inches, then you must take 21.33 Inches, &c.

P R O B. II.

Given the Side of a Square Piece of Timber 14 Inches, and Length 24 Foot, to find its solid Content.

1. *By the Pen.*

Say as 12 is to the Side of the Square 14, so is the Length 24 Feet to 28 a fourth Number. Again, say as 12 is to 14, so is 28 the fourth Number to 32.66, the Content required.

2. *By the Sliding Rule.*

Set 12 upon D to 24 the Length upon C, then against the Side of the Square 14 Inches upon D, you'll find 32.66 Feet upon C for the Content as before.

3. *By the Two Foot Rule, or Gunter's Line.*

Extend your Compasses from 12 to the Side of the Square 14, and that Extent will reach from the Length to 28, and from 28 to 32.66.

N. B. That the same way that you turn your Compasses from 12 to the Side of the Square, the same Way you must turn them twice from the Length to the Content, whether 'tis towards the Right Hand, or to the Left.

Unequal Sided Timber.

There is an unequal sided Piece of Timber, whose Length is 28 Feet, its Breadth 16 Inches, and Depth 10 Inches.

Y 3

P R O B.

P R O B. I.

I demand how many Inches in Length of the said Piece must be taken to make one solid Foot.

1. *By the Pen.*

Divide 1728 by the Product of the Breadth 16, into the Depth 10, and the Quotient would be 10.8 Inches for the Answer.

2. *By the Sliding Rule.*

Find a mean Proportional between 16 Inches and 10 Inches, according to Prob. I. page 55, and that will be 12.64. Then set the mean 12.64 upon D to 12 upon C and against 12 upon D, you'll find 10.8 upon C for the Answer.

3. *By Gunter's Line.*

Extend your Compasses from 12 to the Breadth 16, the same Extent will reach from the Depth 10, (turn'd the same way) to 13.33 a fourth Number. Then as this fourth Number is to 12, so is 12 to 10.8, the Answer as above.

P R O B. II.

To find the solid Content of the said Piece, you may either find a Mean between 16 and 10 by the Pen, as at Prob. I. pag. 19, or by the Sliding Rule, as at Prob. I. pag. 55. which being 12.64 you may by this and the Length 28 Feet, find the Content to be 31.06. According to any of the three Ways given at Prob. II. of Square Timber.

The

The common Method taken to perform this, is to add the Breadth and Depth together; then they call half that Sum, which in this Case is 13, the Side of the Square by which and the Length 28 Feet, you'll find the Content to be 32.85 Feet, which is near two Foot more than it ought to be, but Custom will have it so.

Round Timber.

Note, That you may call that a Timber Tree, the fourth Part of whose Girth at Top is 6 Inches, if it is less it is not reckon'd Timber; And that when you take the Girth of a tapering Tree within 2 or 3 Feet of the Ground, add 6 to the fourth Part of that Girth, then half that Sum will be the fourth Part of the Girth at the Middle thereof.

P R O B. I.

Given the Circumference in the Middle of a Round Tree 60 Inches, to find how much in Length will make one Foot solid.

1. By the Pen.

Say as the Girth 60 is to 42.54 (a Point) so is 12 to 8.51 a fourth Number. Again, as 60 is to 42.54, so is 8.51 to 6.03 Inches, the Answer. According to the Square Equal. But if you'd have it according to the Square inscribed, then say, As the Girth 60 is to 53.25 (a Point) so is 12 to 10.65 a fourth Number. Again, as 60 is to 53.25, so is 10.65 to 9.45 the Answer.

2. By the Sliding Rule.

Set the Circumference 60 upon D to 12 upon C, then against 42.54 upon D, you have 6.03 on C, according to the Square Equal. But to have the Answer according to the Square inscribed, you must set the Circumference 60 upon

upon D, to 12 upon C, then against 53.25 upon D, you have 9.45 as above.

3. By Gunter's Line.

Extend your Compasses from the Circumference 60 to 42.54, and that Extent turn'd twice the same way from 12, will reach to 6.03, or extend from 60 to 53.25, the same Extent turn'd twice the same way from 12, will reach to 9.45 as before.

P R O B. II.

Given the Circumference of a Round Tree taken in the Middle (the Bark being off there) 60 Inches, and Length 32 Feet, to find its Content.

1. By the Pen.

Say as 42.54 is to the Circumference 60, so is the Length 32 Feet to 45 13 a fourth Number. Again, say as 42.54 is to 60, so is 45.13 to 63.65, the Content of the Tree in solid Feet, according to the Square Equal: but to find it according to the Square inscribed, say, as 53.25 is to 60, so is the Length 32 Feet to 36.05 a fourth Number. Again, as 53.25 is to 60, so is 36.05 to 40.62, the Content.

Here we find that the whole Content of the Tree was 63.65 And the Content according to the Square inscribed is 40.62 Their Difference is the Content of the four Slobs ? —

sawn off

5 23 03

2. By the Sliding Rule.

Set 42.54 upon D, to 32 the Length upon C, then against 60 the Circumference upon D, you'll find 63.65 the Content according to Square Equal. Or set 53.25 upon D to 32 upon C; then against the Circumference 60 upon D, you have 40.62 the Content according to the Square inscribed upon C.

3. By

3. *By Gunter's Line.*

Extend your Compasses from 42.54 to the Circumference 60; then the same Extent turn'd twice the same way from 32 will reach to 63.65, the Content according to Square Equal. Or Extend your Compasses from 53.25 to 60, and that Extent turned twice the same way from 32, will reach to 40.62, the Content according to the Square inscrib'd as before.

The Way used by Carpenters is to take the fourth Part of the Girth for the Side of the Square of the Piece, and then find the Content as Square Timber. So if they were to give the Content of the said Piece, whose Circumference is 60 Inches, and Length 32 Feet, their Side of the Square would be 15 Inches, by which and the Length, the Content would be 50 solid Feet, and less than the Truth by 13.65 Feet; however, as they both buy and sell according to this way of Measuring, 'tis what must be submitted to, though not true; but having found the Content of a Piece of Timber in this manner, you may thence find the true Content; this false Content (or any other thus measured) being to the true as 11 to 14. So if you set 11 upon B, to 14 upon A, then against 50 upon B, you'll find 63.6 upon A.

S T O N E.

Stone is measured by the Foot Solid, the most Expeditious Way of doing which, when there are many and well scubbled at the Quarry as they ought to be, is to lay a String from any one Corner Round to its opposite Corner, and that doubled and measured in Feet, or Feet and Inches, must be set down as the fourth Part of the whole Girth, and so do by every Stone in the Parcel, putting all the Quarter Girths under one another; then add them all together, and divide the Sum by the Number of the Stones in the Parcel, and the Quotient will be the Side of a Square
common

common to them all. Having done this, you must have a Line 10, or rather 20 Feet long, and with that take the Length of all the Stones, as if they were laid End to End in a Right Line, and when you have measured the whole Length of your Line, then make a Score to signify one Line, when 'tis up again make another, &c. until you have measured the whole Parcel; then count your Scores, for so many as there are you must reckon so many times 10 or 20 Feet, to which add the odd Feet and Inches (if any.) And having thus obtained the whole Length and Side of the Square common to all, you may find the whole Content as you'd do a Square Piece of Timber of the same Dimensions, by setting 12 upon D, to the Length upon C, then against the Side of the Square upon D, you'll have the Number of solid Feet upon C, which being divided by 20, will reduce them into Tuns, &c.

N. B. That there is a Line of Timber Measure upon the same Side of the Rule that the Line of Board Measure before described is on, and appears thus.

1	2	3	4	5	6	7	8	9 &c. to about 24 Inch.	10
144	36	16	9	5	4	2	2		
0	0	0	0	9	0	11	3		

The Use of this Line is to find how many Inches in Length of a Tree or Piece of Timber must be taken to make one solid Foot, having the Side of the Square or fourth Part of the Girth given. Thus,

If the Side be 1 Inch, then look in the Table, and under 1 you'll find 144 Feet for the Length of a Foot, if 2 Inches, then 36 Feet, if 'tis 7 Inches, then 2 Feet 11 Inches of the Length is to be taken, &c.

But if the Side of the Square or fourth Part of the Girth of a Piece of Timber be above what you have in the uppermost Part of the Table, as 9, 10, 11, Inches, &c. Seek it in the Line, and all the Part of the Rule that is contained

contained between that and the End of the Rule that is towards the Right Hand, is what must be taken for the Length of a Foot, and so often as that is contained in a Piece of Timber, so many solid Feet are in that Piece.

P L A N I M E T R Y.

Or the Art of Measuring Superficies, which are such Figures whose External Parts are only considered without minding Depth or Thickness, as in Painting, Plaistering, &c.

To keep the Book from swelling too fast, I must refer the Reader to the Figures and their Definitions, as they are laid down in the Gauging Part, and supposing the Reader acquainted with Decimals, shall work the Examples that way.

To find the Area of a Square.

R U L E.

Square the Side, or Multiply it by it self, and the Product is the Area, or Superficial Content.

E X A M P L E.

Let ABCD, page 81, be a Square whose Side suppose BC is 16 Feet, 9 Inches, I demand its Content.

16.75

$$\begin{array}{r}
 16.75 \\
 16.75 \\
 \hline
 8375 \\
 11725 \\
 10050 \\
 1675 \\
 \hline
 \text{Facit. } 280.5625 = 280 : 6 : 9
 \end{array}$$

Feet Inch. Parts.

$$\begin{array}{r}
 12 \\
 \hline
 67500 \\
 12 \\
 \hline
 90000
 \end{array}$$

By the Sliding Rule.

Set 1 upon B, to 16.75 upon A, then against 16.75 upon B you'll find 280.56 upon A, the Answer in Square Feet. If you would have the Area in Square Yards. Then set 9 upon B to 16.75 upon A, and against 16.75 upon B, you'll have 31.17 upon A for the Answer, or divide 280.56 by 9, and the Quotient will be the same.

To find the Area of a Parallelogram.

R U L E.

Multiply the Length by the Breadth, and the Product is the Area.

E X A M P L E.

Let ABCD, (page 83,) be a Parallelogram, whose Length AB is 36 Feet 6 Inches, and Breadth BD, 24 Feet 3 Inches, I demand its Content in Square Feet, &c.

24.25

$$\begin{array}{r} 24.25 \\ 36.5 \\ \hline \end{array}$$

$$\begin{array}{r} 12125 \\ 14550 \\ 7275 \\ \hline \end{array}$$

Feet Inch. Parts.

Facit. $885.125 = 885 : 1 : 6$

If the Answer is required in Square Yards 'tis thus:

Feet Inch. Parts. Yards Feet Inch. Parts.

9) $885 : 1 : 6$ $(98 : 3 : 1 : 6$

Or By the Sliding Rule.

Set 9 upon B, to 24.25 upon A, then against 36.5 upon B, you'll find 98.34 Yards.

To find the Area of a Rhombus.

R U L E.

Multiply any Side, as ab by DF, the nearest Distance between that and its opposite Side BF, and the Product is the Area.

E X A M P L E.

Let ab FB be a Rhombus, whose Side ab is 18 Feet, 10 Inches, and nearest Distance to its opposite Side DF 16 Feet 4 Inches, What's its Area? (See Fig. Page 85.)

$$\begin{array}{r} 18.83 \\ 16.33 \\ \hline 5649 \\ 5649 \\ 11298 \\ 1883 \\ \hline \end{array}$$

Feet Inch. Parts.

$307.4939 = 307 : 5 : 10.$

Z

By

By Gunter's Line.

Extend your Compasses from 1 to 16.33, and the same Extent will reach from 18.83 to 307.49 Square Feet.

To find the Area of a Triangle.

R U L E.

Multiply the Base by half the Perpendicular, and the Product is the Area.

E X A M P L E.

Let ACE, Page 87, be a Triangle, whose Base AE is 57 Feet 2 Inches, and Perpendicular CF 36 Feet 6 Inches is given to find the Area.

$$\begin{array}{r}
 \text{AE} = 57.16 \\
 \frac{1}{2} \text{CF} = 18.25 \\
 \hline
 28580 \\
 11432 \\
 45728 \\
 5716 \\
 \hline
 \end{array}$$

$$\text{Facit.} \quad 1043.1700 = 1043 : 02 = 115 : 8 : 2$$

By the Sliding Rule.

Set 9 upon B to 18.25 upon A, then against 57.16 upon B you'll find 115.9 Yards.

By Gunter's Line.

Extend your Compasses from 9 to 18.25, and that Extent will reach from 57.16 to 115.9, as above.

To

To find the Area of a Trapezium.

R U L E.

Having divided the Trapezium into two Triangles, as Figure at Page 89, add the two Perpendiculars AR and FC together, and multiply that Sum by half the Common Base DB, and the Product is the Superficial Content.

E X A M P L E.

Let ABCD be a Trapezium, let the Common Base BD be 72 Feet 8 Inches, the Perpendicular AR = 58 Feet 5 Inches, and Perpendicular FC = 36 Feet 7 Inches given to find its Area or Superficial Content.

N. B. That if you multiply half the Sum of the Perpendiculars by the whole Base 'twill be the same: As in the next Example, in such a Case I always take half that that will be divided by 2 without a Remainder, or multiply the whole, and take half the Product for the Area.

$$\begin{array}{r}
 \text{AR} = 58.41 \\
 \text{FC} = 36.58 \\
 \hline
 \text{Sum is} \quad 94.99 \\
 \frac{1}{2} \text{ DB} = 36.33 \\
 \hline
 28497 \\
 28497 \\
 56994 \\
 28497 \\
 \hline
 \text{Answer,} \quad 3450.9867 = 3450 : 11 : 10
 \end{array}$$

Feet Inch. Parts.

Every Trapezium consists of four unequal Sides, according to the Definition given at Page 89, Therefore the Figure following, viz. DABC is a Trapezium, whose common

mon Base is $DB = 22$ Feet 3 Inches, Perpendicular $AR = 27$ Feet 9 Inches, and Perpendicular $CF = 15$ Feet 1 Inch, the Area of which is found at one Operation, according to the Rule given for the other.

$$AR = 27.75$$

$$CF = 15.09$$

$$\text{Sum is } 42.84$$

$$\frac{1}{2} \text{ Sum is } 21.42$$

$$\text{Base } 22.25$$

$$10710$$

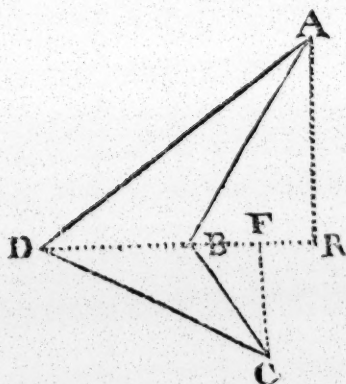
$$4284$$

$$4284$$

$$4284$$

$$\text{Facit. } \underline{\quad\quad\quad} \text{ Feet In. Parts.}$$

$$476.5950 = 476 : 7 : 1$$



To find the Area of a Hexagon.

R U L E.

All regular Polygons, (*i.e.* such whose Sides are equal) may be measured by one General Rule, *viz.* Multiply one Side

Side by the Number of Sides, and that Product by half the nearest Distance of any Side from the Center, so the last Product is the Content.

EXAMPLE.

Let ABCDEF (Fig. at Page 91.) be a Hexagon, whose Side suppose ED is 58 Feet 3 Inches, and nearest Distance OQ = 50 Feet 6 Inches, What's the Area or Content thereof in Square Feet or Yards.

$$ED = 58.25$$

$$\begin{array}{r} 349.50 \\ 25.25 \\ \hline 17475 \\ 6990 \\ 17475 \\ 6990 \\ \hline \end{array}$$

$$8824.8750 = 8824 : 10 : 6 = 980 : 4 : 10 : 6$$

To find the Area of a Circle.

RULES.

1. Multiply half the Circumference by half the Diameter, and the Product is the Area of any Circle.
2. As 14 is to 11, so is the Square of the Diameter to the Area of the Circle.
3. Multiply the Square of the Diameter (taken in any Denomination) by .785398, and the Product will be the Area.
4. Or, As 452 is to 355, so is the Square of the Diameter to the Area of a Circle.

EXAM-

EXAMPLES.

Let ABCD be a Circle whose Diameter AB is 48.2 Feet, What's its Area. (See Fig. p. 93.)

First way, the Circumference of this Circle is (See Page 43.)

$$\begin{array}{r}
 151.42 \\
 \hline
 \text{Half the Circumference is} \quad 75.71 \\
 \text{Half the Diameter is} \quad 24.1 \\
 \hline
 7571 \\
 30284 \\
 15142 \\
 \hline
 \end{array}$$

Facit. 1824.611 Square Feet.

Second way, As 14 : 11 :: 48.2 × 48.2 = 2323.24 : 1825.4 *Answer.*

Third way, Multiply the Square of 48.2 = 2323.24 by .785398, and the Product is 1824.668 the Area.

Fourth way, As 452. : 355. : 2323.24

$$\begin{array}{r}
 355 \\
 \hline
 1161620 \\
 1161620 \\
 696972 \\
 \hline
 \text{Answer} \\
 452.) \cancel{8} \cancel{4} \cancel{7} \cancel{5} \cancel{0} \cancel{7} \cancel{0} \quad (1824.668 \\
 \quad \quad \cancel{3} \cancel{7} \cancel{7} \cancel{1} \cancel{1} \cancel{7} \cancel{0} \cancel{8} (4 \\
 \quad \quad \quad \cancel{1} \cancel{1} \cancel{6} \cancel{1} \cancel{6} \cancel{2} (6 \\
 \quad \quad \quad \quad \cancel{6} \cancel{9} \cancel{6} \cancel{9} \cancel{7} \cancel{2} (2
 \end{array}$$

Of all these four Ways the Second is mostly used, because the two first Numbers are small, but the Area found by them being further from the Truth than either of the other, though sufficient in common Practice, and in small Circles, yet when more Exactness is required, it will be best to use the Fourth, or either of the other Ways.

By

By the Sliding Rule.

First make a Point at .7853 upon C, then set 1 upon D to the said Point upon C, and against 48.2 upon D is 1824 668, the Area required upon C.

To find the Area of a Sector of a Circle.

R U L E.

Multiply the Radius or Semidiameter AB or AC by half the Length of the Arch of the Section, and the Product is the Area.

E X A M P L E.

Let ABqC be a Sector of a Circle (See Fig. at Page 95) and let the Radius AB = AC be 28 Feet 5 Inches, and BC = 20 Feet 6 Inches, What's the Area thereof in Square Feet and Square Yards.

$$\begin{array}{r} \text{AB} = 28.41 \\ \text{Half BC} = Bq \text{ is } 10.25 \\ \hline 14205 \\ 5682 \\ \hline 2841 \end{array}$$

$$\begin{array}{r} \text{Facit. } 291.2025 = 291 : 2 : 5 = 32 : 3 : 2 : 5 \end{array}$$

P R O B. I.

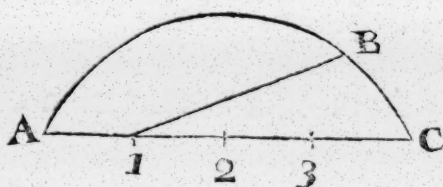
To find the Length of an Arch of a Circle Geometrically.

Let ABC be an Arch-Line given, whose Length is required.

1. Draw the Line AC, which you must always divide into four equal Parts, and set one of them from C to B.

2. Draw

2. Draw a Line from B to the first Division, so have you B 1, and that Line is half the Arch Line ABC, whose double shall be the whole Arch Line, as required.

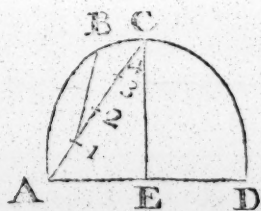


PROB. II.

To find the Length of an Arch Line greater than a Semicircle.

1. Draw AD, and upon the Middle thereof at E erect the Perpendicular EC, and draw the Line AC, which divide into four equal Parts.

2. Take one of those Parts and set it from C to B, and draw the Line B 1 which Line is half the Arch AC; consequently four times B 1 is equal to the Arch Line ABCD.



PROB. III.

To find the Length of the Arch of a Circle Arithmetically.

RULE.

Always multiply the Chord of half the Segment by 8,
and

and from the Product subtract the Chord of the whole Segment, divide the Remainder by 3, and the Quotient will be the Length of the Arch.

E X A M P L E.

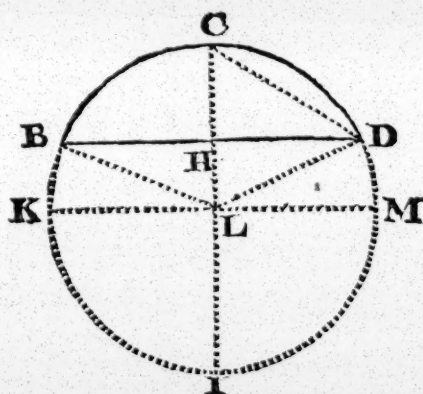
Let the versed Sine $CH=18$, and Chord $BD=48$, be given to find the Length of the Arch Line BCD .

1. By Case the First, Page 22, find $CD=30$, the Chord of half the given Arch, which being multiplied by 8 Produces

2. The Chord of the whole Segment is 48 *Subst.*

Remainder is

One Third Part of which is the Length of the Arch $BCD=64$.



P R O B. IV.

To find the Area of the Segment BCD.

1. Having by the last Problem found the Length of the Arch Line BCD to be 64, then,

2. Find

2. Find HI thus, the Square of $HD = 24$ is 576, which being divided by $CH = 18$, you'll have 32 in the Quotient, which is the Length of HI, to which add $CH = 18$, and the Sum is $50 = CI$, the Diameter of the Circle, the half of which is 25 for the Length of LC or LD.

3. Now by help of the Arch Line $BCD = 64$ before found, and the Radius $LD = 25$, you may find the Area of the Sector $LBCD = 800$.

4. From the Radius $LC = 25$, take the versed Sine $CH = 18$, and there will remain $LH = 7$. So now you have LH and $BD = 48$, as given in the last Problem, to find the Content of the Triangle LBD, which according to the Rule for Measuring a Triangle is 168.

5. From the Area of the Sector $LBCD =$	800
Take the Area of the Triangle $LBD =$	168
	632

The Remainder is the Area of the Segment $BCDH = 632$
So for any other.

Another Way to find the Area of a Segment of a Circle very near the Truth.

R U L E.

To thrice the Square of the Difference between the versed Sine and Radius, add four times their Rectangle or Product, subtract the Sum from 7 Times the Square of Radius, the Remainder is a Dividend. Then to thrice the said Difference add 4.5 times Radius for a Divisor, and the Rectangle of the Quotient into half the Chord, will be the Area of the Segment.

E X A M P L E.

Let the versed Sine be $18 = CH$, and Chord $48 = DB$ be given to find the Area of the Segment $BCDH$. (See the last Figure.)

By the Work of the last Problem, the Radius LC was found to be 25. and Difference between that and the versed Sine CH was $7 = LH$. Then according to the Rule,

Seven

Seven Times the Square of 25. is 4375
 Thrice the Square of 7 is 147. } Sum 847. *Subst.*
 Four Times 7 multiplied by 25 is 700. }
 Remains a Dividend ——— 3538.
 Thrice the said Difference, viz. 7 is 21.
 And 4.5 Times 25 is ——— 112.5

The Sum is a Divisor ——— 133.5
 Then 133.5) 3538.0000 (26.426 Quotient;
 .888000(0
 6783(9
 39(2
 (1

The Quotient 26.426 multiplied by 24, (half the Chord)
 is 634.224, the Area required.

To find the Area of an Oval.

R U L E.

Say as 14 is to 11, or rather as 452 is to 355, so is the
 Rectangle or Product of the Transverse into the Conjugate
 Diameter to the Area or Content.

E X A M P L E.

Let the Tranverse Diameter AB be 32 Feet 3 Inches, and
 Conjugate Diameter CD = 26 Feet 6 Inches. (See Fig,
 Page 97.) I demand its Content.

Feet

Feet.

$$\text{As } 452 : 355 :: 32.25 \times 26.5 = 854.625$$

355.

4273125

4273125

2563875

452) 303391875 (671.221

3218943

05994

000

Answer 671.221 Square Feet, or 74 Yards 5 Feet 2 Inches 7 Parts.

Or if you multiply the Rectangle of the two Diameters, viz. 854.625 by .7854 (a constant Decimal) the Product will be 671.222, the Area differing very little from that above.

By the Sliding Rule.

Set 1.273 (the Square of the Diameter of a Circle whose Area is 1.) upon B to 32.25 upon A, then against 26.5 upon B you'll have 671.22 upon A.

By Gunter's Line.

Extend your Compasses from 1.273 to 26.5, and the same Extent will reach from 32.25, to 671.22 as before.

To find the Content of any irregular Figure must needs be very easy to those who will take notice of what is said about them, at Pages 100, 101, 102, and 103, and understand what has been done in this Part. But as Painters have often Occasion to measure not only the Surface of diverse Sorts of Bodies, but their Solidity also, we will for the sake of such add Rules for both.

STERE-

STEREOMETRY.

Or the Art of measuring Solids, or such Bodies as consists of Length, Breadth, and Thickness, as Timber, Stone, &c. which may happen to be in the Form of any of the following Figures.

To find the Content of a Cube.

R U L E.

Cube its Side, and you have the solid Content:

E X A M P L E.

Let the Side AB equal to AF be 7.5 Feet. I demand its Content. (See Fig. Page 106.)

$$\begin{array}{r}
 7.5 \text{ Feet} \\
 7.5 \\
 \hline
 375 \\
 525 \\
 \hline
 56.25 \\
 7.5 \\
 \hline
 28125 \\
 39375 \\
 \hline
 \text{Facit.} \quad 421.875 \text{ Solid Feet.}
 \end{array}$$

By the Sliding Rule.

Set 1 upon D to 7.5 upon C, then against 7.5 upon D, you'll have 421.875 upon C.

A a

By

3. *By Gunter's Line.*

Extend your Compasses from 1 to 7.5, the same Extent turn'd twice from 7.5 will reach to 421.875, as before.

For the Superficial Content, you must find the Area of one Side, and multiply that by the Number of Sides.

Side	7.5
	<u>7.5</u>
	375
	<u>525</u>
Area of one Side	56.25
	<u>6</u>
Superficial Content	337.50

To find the Content of a Parallelopipedon.

R U L E.

Multiply the Length by the Breadth, and the Product by the Depth, the last Product is the Solid Content.

E X A M P L E.

Let the Length AB be 32.7 Feet, Breadth AE = GF = 2.8, and Depth EF = AG = 3.5 be given to find its Solid Content. (See Fig. Page 108)

$$\begin{array}{r}
 32.7 \\
 2.8 \\
 \hline
 2616 \\
 654 \\
 \hline
 91.56 \\
 3.5 \\
 \hline
 45780 \\
 27468 \\
 \hline
 \end{array}$$

Answer 320.460 Solid Feet.

By the Sliding Rule.

Set 1 upon B, to 2.8 upon A, then against 32.7 upon B you'll have 91.56. Again, Set 1 upon B, to 3.5 upon A, then against 91.56 upon B, you'll have 320.46 upon A.

By Gunter's Line.

Extend your Compasses from 1 to 2.8, and the same Extent will reach from 3.5 to 9.8. Again, Extend your Compasses from 1 to 9.8, and the same Extent will reach from 32.7, to 320.46, the solid Content as above.

The Superficial Content will be the Area of the four Sides, and two Ends added together thus :

AB	32.7	AB=EC	32.7	AE	2.8
AE	2.8	EF =	3.5	AG	3.5
	2616		1635		140
	654		981		84
Area of the upper	91.56	5	114 45	5	9.80
and lower Sides.	91.56	5	114 45	5	9.80
	183.12		229.9		19.6
		A a a		By	

By the preceding Work it appears that } the Area of the upper and lower Sides is }	183.12
Area of the other two Sides is	229.9
And that of the two Ends	19.6
The Sum is the Superficial Content of all	432.62

To find the Content of a Prism.

R U L E.

Multiply the Base of the Triangle at the End by half the Perpendicular, and that Product by the Length will be the solid Content.

E X A M P L E.

Let AC be 5.6 Feet, BD = 3.6 Feet, and AG = DF 26.6. I demand the solid Content. (See Fig. Page 110.)

	AC = 5.6
Half	BD = 1.8
	448
	56
	10.08
Length DF	26.6
	6048
	6048
	2016
Facit.	268.128

Those that can multiply by the *Sliding Rule*, or *Gunter's Line*, need no further Instructions here.

For the Superficial Content, you must find the Area of the three Parallelograms, and two Triangles, their Sum is the Answer.

To

To find the Content of a Cylinder.

R U L E.

Multiply the Square of the Diameter by the Length; then say, as 14 is to 11, or rather as 452 is to 355, so is that Product to the solid Content.

E X A M P L E.

Let the Diameter AB be 4.2 Feet, and Length AC=24.4 Feet, I demand the solid Content. (See Fig. Page 112.)

$$\begin{array}{r} AB = 4.2 \\ 4.2 \\ \hline 84 \\ 168 \end{array}$$

$$\begin{array}{r} AC = 24.4 \\ 17.64 \\ 24.4 \\ \hline 7056 \\ 7056 \\ 3528 \end{array}$$

$$\begin{array}{r} \text{As } 452 : 355 :: 430.416 \\ 355. \end{array}$$

$$\begin{array}{r} 2152080 \\ 2152080 \\ 1291248 \end{array}$$

$$\begin{array}{r} \text{Feet.} \\ 452.) \quad 157797.680 \quad (338.047 \text{ Answer.} \\ 17131606 \\ 362543 \\ 0 \\ A a 3 \end{array}$$

The

The Superficial Content is double the Area of one of the Circles at the End, and also the Area of a Parallelogram, one of whose Sides is the Circumference of the Cylinder, and the other the Length thereof,

To find the Content of a Cone.

R U L E.

Multiply the Square of the Diameter by the Height; then say, as 42 is to 11, so is that Product to the solid Content.

E X A M P L E.

Let the Diameter be $DC = 4.8$ Feet, and Height $AB = 42$ Feet. What's the solid Content. (See Fig. Page 114.)

$$\begin{array}{r}
 DC = 4.8 \\
 \quad 4.8 \\
 \hline
 \quad 384 \\
 \quad 192 \\
 \hline
 AB = \quad 2304 \\
 \quad 42 \\
 \hline
 \quad 4608 \\
 \quad 9216 \\
 \hline
 \quad 967.68 \\
 \quad 11. \\
 \hline
 \text{Feet.} \\
 42.) 10644.48 (253.44 \text{ Feet} \\
 \quad 8400 \\
 \quad 22488(0 \\
 \quad XXX(0
 \end{array}$$

For the Superficial Content, you must multiply Half the Circumference at the Base by the slant Side, and to this Product add the Area of the Circle at the Base.

To

To find the Content of a Square Pyramid.

R U L E.

Multiply the Square of the Side by one Third Part of the Height, and the Product is the solid Content.

E X A M P L E.

Let the Side $CE = AE$ be 7.2 Feet, and Height 34.5 Feet, What's the solid Content? (See Fig. Page 116.)

	AE = 7.2
	7.2
	144
	504
One Third of the Height is	51.84
	11.5
	25920
	5184
	5184

Facit. 596.160 Solid Feet.

N. B. That whatever Figure the Base of a Pyramid may be, whether a Circle, Square, Triangle, Pentagon, Heptagon, or, &c. you need only find the Area thereof, and multiply that by one Third Part of the Height, and you'll have the solid Content.

To find the Content of a Parabolick Conoid.

R U L E.

Multiply the Square of the Diameter by the Height, then say, as 28 is to 11, so is that Product to the solid Content.

E X A M-

$$\begin{array}{r}
 4.3 \\
 4.3 \\
 \hline
 129 \\
 172 \\
 \hline
 18.49 \\
 22.6 \\
 \hline
 11094 \\
 3698 \\
 3698 \\
 \hline
 \end{array}$$

Then 168 : 55 : :

$$\begin{array}{r}
 417.874 \\
 55 \\
 \hline
 2089370 \\
 2089370 \\
 \hline
 \end{array}$$

(168.) 22983.070 (136.803 Facit.)

$$\begin{array}{r}
 61456(6(6 \\
 1130(1 \\
 10
 \end{array}$$

To find the Content of a Spheroid.

R U L E.

Multiply the Square of the Conjugate Diameter by the Transverse Diameter; then say, as 21 is to 11, so is that Product to the solid Content.

E X A M P L E.

Let the Conjugate Diameter be $AB = 6.2$ Feet, and Transverse Diameter $CD = 9.7$ Feet, What's the solid Content thereof. (See Fig. Page 122.)

AB

APPENDIX.

$$AB = 6.2$$

$$6.2$$

$$124$$

$$372$$

$$38.44$$

$$CD = 9.7$$

$$26908$$

$$34596$$

$$\text{Then } 21 : 11 :: 372.868$$

$$11.$$

Feet Solid.

$$21) 4101.848 \quad (195.311 \text{ Answer.}$$

$$708672 \quad 7$$

$$10 \quad 1$$

To find the solid Content of a Sphere or Globe.

RULE.

Cube the Globes Diameter; then say, as 21 is to 11, so is that Cube to the solid Content.

EXAMPLE.

Let the Diameter be AB or CD = 3 Feet, What's the solid Content thereof. (See Fig. Page 124)

AB

A P P E N D I X.

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$$AB = 3. \text{ Feet.}$$

$$\begin{array}{r} 3. \\ \hline 9 \\ \hline 3 \\ \hline \end{array}$$

$$\text{Then } 21 : 11 :: \begin{array}{r} 27. \\ \hline 11. \\ \hline \end{array}$$

$$\begin{array}{r} 21 \overline{) 297.} \text{ (14.14 Solid Feet.)} \\ \underline{21} \\ 87 \\ \underline{84} \\ 30 \\ \underline{21} \\ 90 \\ \underline{84} \\ 60 \\ \underline{60} \\ 00 \end{array}$$

Spheres being to be painted more commonly than most of the solid Figures before mentioned, the Superficial Content is found by multiplying the Circumference by the Diameter.

Thus the Circumference of the Globe above mentioned is $\underline{\hspace{2cm}}$ $\underline{\hspace{2cm}}$ $\underline{\hspace{2cm}}$ $\underline{\hspace{2cm}}$ 9.42

Then $\underline{\hspace{2cm}}$ $\underline{\hspace{2cm}}$ $\underline{\hspace{2cm}}$ $\underline{\hspace{2cm}}$ 3

The Superficial Content is $\underline{\hspace{2cm}}$ 28.26

To find the Content of an Elliptick Cone.

R U L E.

Multiply the Rectangle of the Tranverse and Conjugate Diameters

Diameters by the Height; then say, as 42 is to 11, so is that Product to the solid Content.

EXAMPLE.

Let the Transverse Diameter be $BC = 4.6$ Feet, the Conjugate Diameter $EF = 3.2$ Feet, and Height $AO = 22.4$. What's the solid Content? (See Fig. Page 126.)

$$\begin{array}{r}
 BC = 4.6 \\
 EF = 3.2 \\
 \hline
 82 \\
 184 \\
 \hline
 19.22 \\
 AO = 22.4 \\
 \hline
 11688 \\
 3844 \\
 3844 \\
 \hline
 \end{array}$$

$$\begin{array}{r}
 \text{Then as } 42 : 11 :: 434.128 \\
 11. \\
 \hline
 \end{array}$$

$$\begin{array}{r}
 42) 4775.408 (113.70 = \text{the Solid Cont.} \\
 08890 \\
 \hline
 170
 \end{array}$$

For the Superficial Content you must multiply half the Girth at the Base by the slant Height.

To find the Content of the Frustum of a Cone.

RULE.

Find the Area of a Circle at the Top, and of that at the Bottom, and also a Mean between these two Areas. Add all

all three together, and multiply the Sum by one third Part of the Height, the Product will be the solid Content.

E X A M P L E.

Let the Top Diameter be $AC = 5.6$ Feet, Bottom Diameter $DF = 6.8$ Feet, and Height $BE = 16.5$ Feet; What's the solid Content? (See Fig. Page 128.)

The Area of the Top is	_____	24 64
Area of the Bottom is	_____	36 33
A Geometrical Mean is	_____	29 92

The Sum of these Three is	_____	90.89
---------------------------	-------	-------

One third of BE is	90.89
--------------------	-------

	5.5
--	-----

	45445
--	-------

	45445
--	-------

The solid Content is	499.895
----------------------	---------

The Superficial Content is found by multiplying half the Sum of the Circumferences of the Top and Bottom by the Height, and to that Product add the Areas of the Top and Bottom: So will the Sum be the Answer.

To find the Content of the Frustrum of a Parabolick Conoid.

R U L E.

Add the Area of the Top, to the Area of the Bottom, and multiply that Sum by half the Height, so will the Product be the solid Content.

E X A M P L E.

Let the Top Diameter be $AC = 5.6$ Feet, Bottom Diameter $B b$

ter

ter $DF = 6.8$ Feet, and Height $BC = 16.5$ Feet. What's the solid Content? (See Fig. Page 132.)

The Area of the Top is	_____	24.64
Area of the Bottom is	_____	36.33
Sum is	_____	60.97
Half the Height is	_____	8.25
		304.85
		121.94
		487.76
The solid Content is	_____	503.0025

The Superficial Content may be found near enough the Truth in Practice, by taking a mean Girth somewhere between the Top and Bottom, and to the Product of that into the Height, add the Areas of the Top and Bottom.

To find the Content of the Frustum of an Elliptick Cone.

R U L E.

To the Area of the Top add the Area of the Bottom, and also a Mean between these two Areas, multiply the Sum by one Third Part of the Height, and the Product shall be the solid Content.

E X A M P L E.

Let the Transverse Diameter at the Top AB be equal to 2.15 Feet, the Conjugate Diameter $CD = 1.2$. The Transverse Diameter at the Bottom $FE = 3.32$. Conjugate Diameter $1.6 = GH$, and Height $IK = 4.5$ Feet, to find the solid Content, (See Fig. Page 138.)

The

The Area of the Top is	_____	2.02
Area of the Bottom	_____	4.17
A mean Proportional is	_____	2.92
Sum is	_____	9.11
One Third Part of the Height is	_____	1.5
Product is the solid Content	_____	13.665

The Superficial Content may be found near enough in Practice, by multiplying half the Sum of the Girths at the Top and Bottom by the Height.

To find the Content of the Frustum of a Globe.

R U L E.

To thrice the Square of the Semidiameter of the Frustum's Base, add the Square of its Height, and multiply the Sum by the said Height of the Frustum. Then say, as 21 is to 11, so is that Product to the solid Content.

E X A M P L E.

Let $AB = 22.8$ Feet be the Diameter of the Frustum's Base, and $CD = 34.2$ Feet be it's Height. (See Fig. Page 143)

B b 2

Half

Half AB = AC is

114

114

456

1254

The Square of AC is

129.96

3.

The Square of CD = 34.2 is

389.88

1169.64

Sum is

1559.52

34.2

311904

623808

467856

53335.584

11

21) 586691.424 (27937.686
 16976484(8
 101111(1

Hence the solid Content is 27937.686 Feet.

To find the Superficial Content of the Frustum of a Sphere, say, as the Diameter of the Sphere is to the Superficial Content of the Sphere. So is the Height of any Frustum to its Curve Superficies, to which add the Area of the Frustum's Bate, and the Sum is the whole Superficial Content of the Frustum

Having thus done with Superficial and Solid Measure, I can't but think that it will be acceptable to add a few Pages upon Surveying of Land.

Surveying

Surveying of LAND.

TH E most common and most easy Instrument for this Purpose is the plain Table, which is a Parallelogram about fourteen Inches and a half long, and eleven broad, and so larger in Proportion as the Surveyor thinks most proper; upon which there is a graduated Frame to serve instead of a Semicircle, Theodolite or Circumferentor, and has also a Box and Needle screwed to the Side thereof to take the Bearings of Places, or give notice of any Error that may happen in the Course of a Survey.

This plain Table so made up, is moved upon a three-legg'd Staff, with a Ball and Socket, and so by help of an Index with Sights, is fit to take Observations, either by Angles and Distances of Objects, and afterwards Mapp from such Observations: Or having a Sheet of Paper fastened thereon by the said Frame, you may Measure and Mapp at the same Time, with as much certainty (especially in dry Weather) as by any Instrument whatever.

Besides this, you must have a Scale with a Diagonal Line, a Line of Chords, and Lines of equal Parts of several Lengths, together with a Pair of Compasses, and a Chain.

The best Chain for this purpose is that they call *Gunter's Chain*, being 22 Yards long, or 4 Perches, each 5 5 Yards, and contains 100 Links, each Link being 7.92 Inches long.

When you Measure with this, you may either write down the Number of Chains, and on the Right Hand thereof make a Comma or Point, and after that set down the odd Links, or for every Chain reckon 100, and add the odd Links to that. So if you was to set down 7 Chains and 32 Links, it may stand thus, 7 32, or 732. Links, and in casting up the Acres 'tis always considered in this — last Form, for a Reason which will be given in its proper Place.

To take the Plot of a Field at one Station in any Part thereof as A, from whence you may see all the Angles or Corners thereof.

1. Plant your plain Table (being covered with a Sheet of Paper) at A, from whence you may see all the Angles, having first stuck up Pieces of white Paper at each, the better to be seen.

2. Direct your Sights to every Angle, from a Point A, taken at Pleasure on the plain Table, and having measured the Distance between the Table and each Angle in Chains and Links, take them in your Compasses from your Diagonal Scale, and set them respectively from A to B, from A to C, from A to D, &c. which being done, draw Lines from B to C, from C to D, from D to E, &c. to complete the Figure BCDEFGH, which will be the true Shape of the Field; this being had, you may then divide it into such Figures as may be most convenient, in order to know how many Acres the same contains, as you see done in the second Figure.

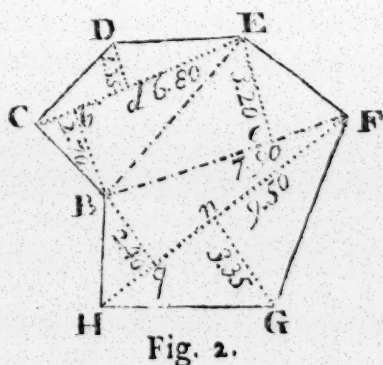
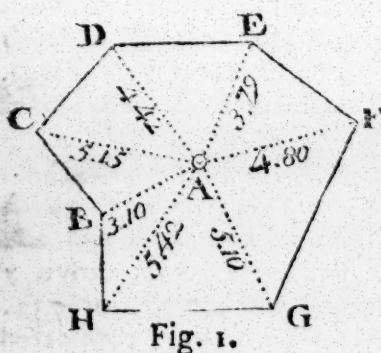


Figure the Second being divided, is reduc'd to two Trapeziums BCDE, and BFGH, and one Triangle BEF, the

A P P E N D I X.

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the measure of whose Bases and Perpendiculars taken by the same Diagonal Scale that Fig. 1. was laid down from, are there set down, and the Content of each as follow.

$$CE=6.80 \left\{ \begin{array}{l} Dd=1.35 \\ Bb=2.70 \end{array} \right.$$

$$\begin{array}{r} \text{Sum is} \quad 4.05 \\ \text{Half CE is} \quad 3.40 \end{array}$$

$$\begin{array}{r} 1620 \\ 1215 \end{array}$$

$$\text{Content of BCDE} = 1.37700$$

$$HF=9.50 \left\{ \begin{array}{l} Bq=2.40 \\ Gn=3.35 \end{array} \right.$$

$$\begin{array}{r} \text{Sum is} \quad 5.75 \\ \text{Half HF is} \quad 4.75 \end{array}$$

$$\begin{array}{r} 2875 \\ 4025 \end{array}$$

$$2300$$

$$\text{Content of BFGH} = 2.73125$$

$$BF=7.90 \left\{ \begin{array}{l} Ec=3.20 \\ \text{Half is } 1.60 \end{array} \right.$$

$$\begin{array}{r} 474 \\ 79 \end{array}$$

$$\text{Content of BEF} = 1.16400$$

$$\begin{array}{r} \text{Then BCDE} = 1.37700 \\ \text{BFGH} = 2.73125 \\ \text{and BEF} = 1.16400 \end{array}$$

$$\begin{array}{r} \text{Sum of all is} \quad 5.37225 \\ 4 \end{array}$$

$$\begin{array}{r} \text{Roods} \quad 1.48900 \\ 40 \end{array}$$

$$\begin{array}{r} \text{Perches} \quad 19.56000 \end{array}$$

Hence it appears that the Content of this Piece of Land is, five Acres, one Rood, and nine Perches or Poles.

N. B.

N. B. That from every one of the three Products first above found, I have cut off five Figures towards the Right Hand, and so a Stranger to this Art would be apt to think that I should have cut off but four, there being but so many Decimal Places in both Factors: But let us consider the first Product, viz. 137700 for Instance, which is produc'd from 4 Chains and 5 Links, or 405 Links, multiplyed by 3 Chains and 40 Links, or 340 Links; therefore 137700 are so many square Links for the Content of that Trapezium. But 160 Square Perches are one Statute Acre, then a Parallelogram, that is, 4 Perches equal to one Chain, or 100 Links broad, and 40 Perches equal to 10 Chains, or 1000 Links long, is a Statute Acre, but the Breadth 100 Links, multiplyed by the Length 1000 Links, produces 100000 Square Links, and so many are in a Statute Acre. Therefore divide any Number of Square Links by 100000, and the Quotient is Acres; and that's done by pointing off a Figure for every Cypher in 100000, that is five, according to which Rule 137700, will be 1.37700, as above; and so of any other.

To take the Plot of a Field at two Stations, when all the Angles thereof cannot be seen at one.

1. Let ABCDEFGHIKL be the Field that's to be measured, then having walk'd about it, and stuck up Pieces of white Paper at every Angle, go to some two Places, suppose M and N, from whence all the Angles may be seen, and call these your two Stations, of which M may be your first, where setting up your plain Table, turn it so that the North End of the Needle may point to the North Point of the Compasses that is in the Box.

2. Lay the fiducial Side of your Index over the first Station at M, direct it to K. L. A. B. C. and with one Point of your Compasses draw blank Lines towards each Angle, and having measured the Distance of each from your Station, set them down from your Diagonal Line as you see;

see; and draw a Line from K to L, from L to A, from A to B. and from B to C, so will you have the true Shape of one Part of the Field.

3. Direct your Sights to the second Station at N, and towards that draw the Line Mq; and having found the Distance between the two Stations to be, suppose six Chains and seventy Links, set that from M to N, so is N your second Station upon the Table.

4. Remove it to N, and having laid the same Side of the Ruler or Index upon the Line Mq, by which it was drawn, turn the Table about until you can see your first Station through the Sights, then observe the Needle, and if it hangs over the North Point as you set it at the first Station, then is your Table rightly set.

5. Being now at N, lay your Index to that Point, and direct it to D. E. F. G. H. I. and towards each of them draw Lines, as ND. NE. NF, &c. and from N set off the Chains and Links that answers to those Distances respectively; which being done, draw a Line from D to E, from E to F, from F to G, from G to H, and from H to I: and thus you have obtained the true Shape of the whole as Fig. 1. The Second is the same Piece divided, in order to find the Content thereof.

Fig. 1.

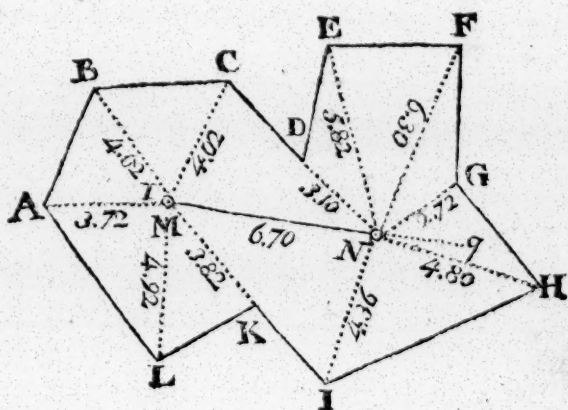


Fig.

A P P E N D I X.

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$$DK = 4.32 \begin{cases} Ib = 3.12 \\ Li = 2.00 \end{cases}$$

$$DH = 7.86 \begin{cases} Gm = 1.60 \\ In = 5.58 \end{cases}$$

$$\begin{array}{r} \text{Sum } 5.12 \\ \text{Half DK} = 2.16 \end{array}$$

$$\begin{array}{r} \text{Sum} = 7.18 \\ \text{Half DH} = 3.93 \end{array}$$

$$\begin{array}{r} 3072 \\ 512 \\ \hline 1024 \end{array}$$

$$\begin{array}{r} 2154 \\ 6462 \\ \hline 2154 \end{array}$$

$$\text{Cont. of DIKL} = 1.10592$$

$$\text{Cont. of DGHI} = 2.82174$$

$$EG = 5.74 \begin{cases} DI = 3.00 \\ Fx = 2.92 \end{cases}$$

$$\begin{array}{r} \text{Sum } 5.92 \\ \text{Half EG} = 2.87 \end{array}$$

$$\begin{array}{r} 4144 \\ 4736 \\ \hline 1184 \end{array}$$

$$\begin{array}{l} \text{Content of DEFG} = 1.69904 \\ \text{DGHI} = 2.82174 \\ \text{DIKL} = 1.10592 \\ \text{LABC} = 2.54370 \\ \text{DCL} = 0.93090 \end{array} \left. \vphantom{\begin{array}{l} \text{Content of DEFG} \\ \text{DGHI} \\ \text{DIKL} \\ \text{LABC} \\ \text{DCL} \end{array}} \right\}$$

$$\begin{array}{r} \text{Sum } 9.10130 \\ 4 \end{array}$$

$$\begin{array}{r} .40520 \\ 40 \end{array}$$

$$\begin{array}{r} 16.20800 \end{array}$$

The Content of the whole Piece is 9 Acres, 16 Perches.

To

To take the Plot of a Field by measuring to the several Angles as you go round about the same

1. Let EFGHIKLM& be a Piece of Ground to be measured, go round about it, and stick up Papers at each Angle, so you'll know how many Stations will be necessary, and where to place them: now in this Case four will be sufficient, viz. at A, B, C, and D, where place four long Sticks with Papers upon them, and then planting your Instrument at any one of them, suppose at A, (which call your first Station) direct the Sights to Z and E, and draw Lines from A towards each, then measure their Distances with your Chain from the Station at A, viz. $AZ = 250$, and $AE = 100$, and set them off from your Scale to Z and E, which being done, draw the Line ZE for one Side of the Field.

2. Direct the Sights from the Point A, to the second Station at B&, draw a Line as AB, then take up your Instrument from A, and set up the Station Stick in its Place, and advance towards B; but having gone one Chain and 76 Links that way, you come to the Corner at F, then taking 1.76 in your Compasses from the Diagonal Line, set that Extent from A to F, and draw the Line EF for another Side, and going still forward, at 4 Chains and 16 Links, you'll come to e, opposite to the Angle G, to which measure, and finding it to be 1.38, take that in your Compasses, and set it from e to G, and draw GF for a third Side, then go on to the Corner at H, which is 8 Chains and 16 Links, from the Station at A, take this in your Compasses and set it from A to H, and draw GH for a fourth Side, then go on in the same Direction to the second Station at B, whose Distance from A you'll find to be 8 Chains and 86 Links, which being taken in your Compasses, set that Extent from A to B, and at B write a Figure of three, to signify the Place of your present Station.

3. Set

3. Set up your Instrument at B, and laying the Fiducial Side of the Ruler on which your Sights are placed upon the Line AB as you laid it when you drew that Line, turn the Table so that looking through the Sights you may see the Station Stick which you left at A, then screw the Table in that Position, and laying the Index or Ruler upon the Station point B, direct the Sights to the several Corners at I, K and L, and draw Lines from B towards each, then with your Chain measure the Distances from the Station point B, viz. $BI = 1.50$, $BK = 2.12$, and $BL = 1.92$, take these respectively in your Compasses from the Diagonal Line, and set them from B, to I, K and L, and draw the Lines HI, IK, and KL.

4. The Table remaining fix'd, direct the Sights to the third Station at C, and towards C draw the Line BC, then take up your Table, and leaving a Station Stick with a Paper upon it at B, proceed towards the third Station, and having measured 3 Chains and 20 Links that way you come to the Angle at M, then take 3.20 in your Compasses, and lay that Extent upon the Line BC, from B to M, and draw LM. Advancing still towards C, after having gone 5 Chains and 10 Links from B to *f*, you then come opposite to N, measure *f* N and 'tis 96 Links, which being set from *f* to N, draw MN. Then proceed to the Angle at O, which you'll find to be 8 Chains from B; set these upon the Line BC, from B to O, and draw NO. From O go to the third Station at C, whose Distance from B is 10 Chains and 30 Links, which take from your Diagonal Line, and set it from B to C, and at that point make the Figure 3 to denote the third Station.

5. Being now at your third Station C, plant the plain Table there, and laying the fiducial Edge of the Rule upon the Line BC, the same Way that you drew that Line turn the Table so that looking through the Sights you may see the Paper that's upon the Station Stick at B, and then having screw'd it fast, lay the Ruler upon the point C, and direct the Sights to P. Q. R and S. drawing Lines from C to-

C c

ward;

wards each, and then measure their Distances, viz. $CP = 1.92$, $CQ = 70$, $CR = 1.92$, and $CS = 2.72$, and set these from C to P. Q R and S, and draw the Lines OP, PQ, QR and RS.

6. Your Table remaining fix'd : Direct the Sights to the fourth Station at D, and draw the Line CD, then take up the Table, and leaving a Station Stick with a Paper upon it in the Place, go towards the fourth Station 5 Chains and 60 Links, and you come to the Angle at F. Therefore take 5.60 in your Compasses, and lay that Extent from C to F, and having drawn SF, proceed on your way to the fourth Station at D, whose Distance from C you'll find to be 10 Chains and 90 Links, take 10.90 in your Compasses and lay that Extent from C to D, where make the Figure 4, to signify your fourth Station.

7. Having set up your Table at this fourth Station, lay the Ruler upon the Line CD, the same way that you drew it before, and letting it lie so placed, turn the Table gently about until looking through the Sights you see the Station Stick that you left at C, then screw it fast, and directing the Sights from D to V and W, draw Lines from D towards those Corners, and having measured their Distances, viz. $DV = 90$, and $DW = 252$, lay these from D to V and W, then draw the Lines FV and VW.

8. The Table remaining unmov'd, lay the Ruler upon the Points D and A, and then looking through the Sights, if you see the Stick that you left at A, you may conclude that your Table has been rightly placed at the other Stations, as well as where it is, and to be farther satisfied before you leave that Station. If when you direct your Sights from D, to any or all the Angles of the Field in View, the fiducial Edge of the Ruler falls exactly upon those Points on the Paper that was made to represent those Angles, then you may be sure that so much of your Work is true; and being thus satisfied, you may take up your Table and measure on towards A your first Station, 2 Chains and 20 Links, when you'll come to g opposite to the

To take the Plot of a Piece of Ground at two Stations within the same, from either of which all the Angles in the Piece may be seen by measuring only the Distance between those two Stations.

Let the Piece CD, E, F, G, H, &c. be to be measured in this manner :

1. Having walk'd about it and set up white Papers at each Angle find out two such Stations, suppose A and B, from either of which all the Corners or Angles may be seen, and there set up two Sticks with white Papers upon them, the better to be seen at a Distance.

2. Set up your plain Table at A, turning it so that it may stand Length ways towards C and I, that so you may have room on the Paper that you have upon the Table to draw Lines towards G, H, I, K, which are longer towards those Angles than the other.

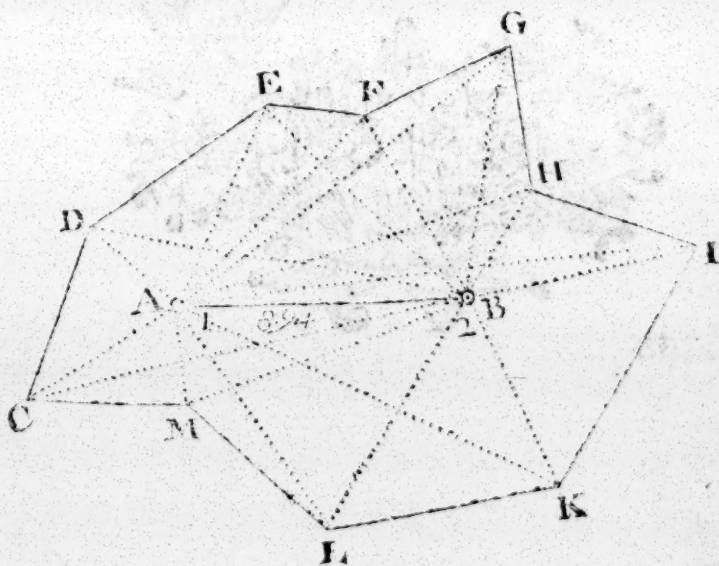
3. Make choice of some Point, suppose 1, for your first Station upon your plain Table to represent A in the Field, then lay your Index with Sights upon the point 1 or A, direct it towards the several Angles C, D, E, F, G, H, I, K, L, and M, and draw occult Lines towards each, this being done, direct the Sights to the Station at B, and towards that draw the Line AB, and set up a Station Stick with a Paper upon it at B, then take your Table to B, and as you go measure the Distance AB, which let be 8 Chains and 94 Links. Take 8 94 in your Compasses from the Diagonal Line, or any other Line of equal Parts, and lay that Extent from A to B, and at B set up your Table, and lay the fiducial Edge of the Ruler upon the Line AB, the same way that you did when you drew that Line, then turn the Table so that you may see the Paper through the Sights
that

that you left upon the Stick at the first Station A, and then screw it fast.

4. Lay the fiducial Edge of the Rule upon the Point B, and direct the Sights the several Angles C, D, E, F, G, &c. as before, and draw Lines towards those Angles until they intersect the Lines that you drew towards them from A, so the Line BC will intersect the Line AC in C, BD will intersect the Line AD in D, BE will intersect AE in E, &c.

5. From the several Points of Intersection as C, D, E, F, &c. draw the Lines CD, DE, EF, FG, GH, &c. quite round, so will you have the true Plot of the Field, which by reducing it into proper Figures you may cast up as before.

N. B. That this Way should be practis'd only upon even Ground.



When the 1st Example is thoroughly understood, you may very easily see the manner of taking the Distance of Places either from your first or second Station, or from one another; for pursuing the Method here delivered you have the Distance of the Object F, (for Instance) from G and AF, and AG, their Distance from the first Station, also BF, and BG, their Distance from the second Station in the same Denomination that you measured the Line AB by, whether Feet, Yards, Chains, &c.



Errata



Errata et Addenda.

PAGE 40. last Line but one, *for a Cone, read, the Cone*

Page 45. l. 16. *r. the Product shall be the Duty.*

Page 46, l. 27. *for but 1, r. 1. p. 47. l. 13. r. that which is in the place of Units must be, &c.*

Page 49. l. 18. *after as above, add, Or the Places in the Product must be equal to those in both the Factors, but when the two first Figures of the Product exceed those of the lesser Factor, then it will have one place less.*

Page 61. l. 7. *add, however there yet remains another way to find the Content of a Spheroidal Cask in Beer or Wine Gallons; having the Diagonal in Inches, by help of the Lines C and D: Thus,*

For B E E R.

Set 21.28 (a Gauge point) upon D, to the Length of the Diagonal in Inches upon C, then against the same Diagonal on D, you'll have the Content of the Vessel in Beer Gallons upon C.

For

For WINE.

Set 19.15 (a Gauge point) upon D, to the Diagonal in Inches upon C, then against the same Diagonal upon D, you'll have the Content upon C.

Page 61. l. 22. for, 8.89, r. 88.9. p. 67. l. 3. add, or thus, Set 16 upon B, to 12 upon A, then against 12 upon B, you'll have 9 for the Answer upon A.

Page 75. l. 15. dele the Height of. p. 76. l. 21, 22. dele, of any Thickness.

Page 83. l. 9, add, The Gauge points for a Square, or other Right-lin'd Figures are 16.79 for Beer Gallons, 15.19 for Wine, and 46.36 for Malt Bushels, as at Page 107, and by these you may find the Area of a Square in these three Denominations at one set of the Rule, Thus, first put the Line C the Reverse way into its place, then set Unity upon the Line C to the Side of the Square 30 upon D, and against 16.79 upon D, you'll have 3.191 upon C, against 15.19 upon D you'll have 3.896 upon C, and against 46.36 upon D, you'll have .4186 upon C, as before.

Page 94. after l. 28. add, Or rather thus, the Gauge points for a Circle being 18.94 for Beer Gallons, 17.14 for Wine Gallons, 52.32 for Malt Bushels.

Set these severally upon D to Unity upon C, then against 40, the Diameter upon D, you'll have the several Areas as above upon C. Or you may find these Areas at one set of the Rule, thus, Set the Diameter 40 upon D, to 1 upon C, (the Sliding piece C being put the Reverse way into its place) then against the several Gauge points above-mentioned

mentioned upon D, you'll have the Areas upon C, as before.

Page 100. l. 25. add, if more Exactness is required,

1. Then divide the Square of half the Chord by the versed Sine, and the Quotient will be 21.61, to which add the versed Sine 5.7, and the Sum is 27.31, the Diameter of the whole Circle.

2. Say as 14 to 11, so is the Square of the Diameter to 586.013, the Area of the whole Circle.

3. Divide the versed Sine 5.7, by the Diameter 27.31, and the Quotient is, 21 fere.

4. Find 21 under V in the Table of Segments at Page 165, and against it you have .1527 a Decimal, by which if you multiply the Area of the whole Circle, the Product will be 89.484185, the Area of the Segment in Square Inches, which you may divide by 282, 231, and 2150, as before

Page 107. l. 19. add, you may find the Content of the Cube at one Set of the Rule in Beer, Wine, and Malt, thus, Set the Side of the Cube 20 upon D, to 20 upon C, (the Sliding piece C being put into its Place revers'd) then against the several Gauge points upon D, you'll have the several Contents as above upon C.

Page 109. l. 18. add, At the latter End of the first Edition of this Book which was printed in 1707, I proposed a Method for finding the Content of a Cestern, or Couch of Malt at one Set of the Rule, without finding a Mean between the Length and Breadth as above : Which till then was the only Way in Use, and from thence a Line called the Reverse Line was taken, (as I then hoped) and mark'd M. D. for Malt Depths, and is much esteemed in the practice of Gauging. The

The Use of it is thus, Set the Length 40 upon B, to the Depth 15 upon the Line M. D. then against the Breadth 20 upon A, you'll find 5581 upon B. (See the last Example) and so for any other.

Page 111. l. 17. add, Or set the Depth 60 upon B, to half the Perpendicular = 11 upon M. D. then against 40 upon A you'll have 12.27 upon B as before.

Page 112. the Work for the Content in Beer Gallons should stand thus,

$$\begin{array}{r} 359) 96000.000 \quad (267.409 \\ \quad 242674(6(9 \\ \quad \quad 2643(1 \\ \quad \quad \quad 10 \end{array}$$

Page 113. l. 25. add, The Content in Beer, Wine, and Malt, may be had at one Set of the Rule, thus, Set the Depth 60 upon the Sliding Piece C, (being put the Reverse way into its Place) to 40 the Diameter upon D, then against the Ale Gauge Point upon D you'll have 267 4 upon C. Against the Wine Gauge Point upon D you'll have 326.53 upon C, and against the Malt Gauge Point upon D, you'll have 35 068 upon C as before. The same may be done for a Cone by using $\frac{1}{3}$ of the Depth, for a Globe by $\frac{2}{3}$ of its Diameter, for a Spheroid $\frac{2}{3}$ of its Height or Transverse Diameter for a Parabolick Conoid, then $\frac{2}{3}$ of the Height, for a Hyperbolick Conoid $\frac{1}{3}$, if for a Parabolick Spindle then $\frac{8}{15}$ of its Height.

Page 115. l. 23. add, The Reason why you set the Diameter upon D, to one Third of the Cone's Height upon C, is, because a Cone is one Third of a Cylinder of the same Diameter and Height.

For the same Reason if you was to find the Content of a Globe, then you must set its Diameter upon D, to two Thirds of the solid Diameter upon C.

If 'tis a Spheroid, then you must set the Conjugate Diameter upon D, to two Thirds of the Transverse Diameter upon C. If

If a Parabolick Conoid, then set the Diameter upon D, to one Half of the Height upon C.

If an Hyperbolick Conoid, the Diameter upon D, must be set to five Twelfths of its Height upon C, and if this is a Parabolick Spindle, then the Diameter on D, must be set to eight Fifteenths of its Height upon C, and against the several Gauge Points you'll have the Contents, as for the Cone. See Page 189, 190.

Page 178. l. 31. add, To find the Increases at several Inches Wet by the *Sliding Rule*, useful in the Distillery.

R U L E.

Set the Diameter upon C, to 100 on Seg. Ly. and set down the Segments answering to the several Depths, or Wet Inches. Then Subtract the first Segment from the Second, the Second from the Third, the Third from the Fourth, &c. and call the Remainders, the Encrease Segments.

Having found these, Set 100 upon B, to the Casks whole Content upon A, then against the first Segment, and the several Encrease Segments on B, you'll have the several Encreases on A, which being added together will (if true) give the Casks Content.

E X A M P L E I.

Let the Content of a Cask be 98.4 Wine Gallons, and Bungs Diameter 30 Inches:

And suppose the Inches Wet. Segm. Encr. Seg. Gallons.

14	45		44.3
19.5	.71—	.45=	.26 25.6
25.3	.92—	.71=	.21 20.7
28.	98—	.92=	.06 59
30 Full	100—	98=	.02 1.9

Sum is the Cask's Content

98.4
E X A M-

(300)

EXAMPLE II.

Let a Cask of the same Dimensions be given, but standing on one End the Content being 98.4 Wine Gallons, and Length 38 Inches.

To find the several Encreases in this Position, you must use the Length hereas you did the Bung's Diameter before, but use the Segment standing upon the Sliding Rule:

Suppose the Wet.	Segm.	Encr.	Seg.	Gallons.
14	.35			34.5
19.5	.51—	.35=	.16	15.7
25.3	.68—	.51=	.17	16.7
28	.75—	.68=	.07	6.9
38 Full	1.00—	.75=	.25	24.6

Sum is the Cask Content

98.4

F I N I S.



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e,

